SPACE MEDICINE RESEARCH

THE UNIVERSITY
OF MICHIGAN

AUG 16 1960

MAIN
READING ROOM

HEARINGS

BEFORE THE

SPECIAL INVESTIGATING SUBCOMMITTEE

OF THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS

U.S. HOUSE OF REPRESENTATIVES

EIGHTY-SIXTH CONGRESS

SECOND SESSION

JUNE 15 AND 16, 1960

[No. 12]

Printed for the use of the Committee on Science and Astronautics

UNITED STATES
GOVERNMENT PRINTING OFFICE
58044 WASHINGTON : 1960

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SPACE MEDICINE RESEARCH

WEDNESDAY, JUNE 15, 1960

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SPECIAL INVESTIGATING SUBCOMMITTEE,
Washington, D.C.

The subcommittee met at 10 a.m., Hon. Overton Brooks (chairman) presiding.

The CHAIRMAN. The committee will come to order.

This morning is the first of the 2 days of hearings by the Special Investigating Subcommittee of the Committee on Science and Astronautics on the general subject of space medicine research.

It is my view that the ultimate goal of much of the effort to do space research is the capability for human travel to other places in the Solar System, and the use of manned laboratories in orbit around the Earth. There is much more to this than merely to prove such things can be done as a stunt. Although the ultimate benefits may be obscure, there are many tangible payoffs which can already be foreseen by the experts.

Project Mercury represents an important beginning to manned space flight, as does the X–15. Coming down the road is Dyna-Soar which will do even more. But well beyond these currently identifiable projects are extremely important efforts not yet named which require intensive research on many aspects starting now. This is because of long leadtime problems. If we are to have a capability to do complex things in space when Saturn, Nova, and Rover are operational as booster systems, we must pay immediate attention to our research on biological and biotechnological systems.

The purpose of these hearings is to review what our present facilities for such research and development are today in NASA and each of the three armed services. We want to know something of their plant and equipment, their personnel, their capabilities. We want to know something of the work they are pursuing and what studies they think should be carried out in this area in the years immediately ahead. We want to know if they are satisfied with the funding, the plans, and the organizational pattern which is forming to meet these needs.

The first witness this morning is Dr. Clark T. Randt, Director of the Office of Life Sciences Programs, National Aeronautics and Space Administration.

Dr. Randt is famous as a neurologist and has been widely hailed as an excellent choice for heading this new major office in NASA.

This morning we will be very happy to hear from Dr. Randt as our first witness.

Do you have a prepared statement, Doctor?

Dr. RANDT. No, sir, I don't. Unfortunately I was out of town when news of this hearing reached me.

The CHAIRMAN. I understand you have been out of town and just came in and you haven't been able to form a definitely prepared statement.

Dr. RANDT. Yes.

The CHAIRMAN. Well, what we want in the hearings, as I have said, is something to bring us down to date. I envision during the course of the adjournment of Congress that some of our members would like, perhaps, to visit the space facilities at San Antonio and other places, such as Pensacola, Fla., and other facilities throughout the country. We should therefore have some hearings on this subject before that time. So if you will, sir, we will be glad to hear from you.

STATEMENT OF DR. CLARK T. RANDT, DIRECTOR OF THE OFFICE OF LIFE SCIENCES PROGRAMS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION [1]

Dr. RANDT. Thank you, Mr. Chairman. I am pleased to have this opportunity to present the material on the life science programs of the National Aeronautics and Space Administration today.

In accord with the mandate given the National Aeronautics and Space Administration in the Space Act of 1958 concerning "activities in space devoted to peaceful purposes for the benefit of all mankind," it is appropriate that the study of life processes in this new environment should constitute a significant part of the total effort.

May I have the first slide, please?

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[1] Biography of Clark T. Randt, M.D., Director, Office of Life Sciences Programs, National Aeronautics and Space Administration:

Clark T. Randt was appointed Director, Office of Life Sciences Programs of the National Aeronautics and Space Administration on Mar. 1, 1960. He joined the NASA on Apr. 1, 1959, as scientist for space medical research. In this capacity he had an opportunity to evaluate personnel, facilities, and programs in the space-related life sciences in the military service laboratories, industry, research institutes, and universities throughout the country for the purpose of assisting in the planning of a life sciences program for NASA. He served as Executive Secretary of the NASA Bioscience Advisory Committee. He is now responsible for activities in biology, medicine, and psychology conducted by the NASA.

Born in Lakewood, Ohio, in 1917, Dr. Randt graduated from Colgate University with an A.B. degree in 1940, and from Western Reserve University, School of Medicine, in 1943. Following internship and an assistant residency in internal medicine at the university hospitals of Cleveland and completing a course in military neuropsychiatry at the U.S. Army Mason General Hospital, Brentwood, Long Island, he was assigned to the staff of this Army psychiatric center from 1945 to 1947. He was a resident in neurology at the Neurological Institute of New York of the Columbia Presbyterian Hospital from 1947 to 1950, and on the faculty of Columbia University as an assistant in neurology. Dr. Randt came to the School of Medicine, Western Reserve University, in 1950, and was appointed associate professor of neurology in 1952, as well as the director of the Electroencephalographic Laboratory which he had established in the university hospitals of Cleveland in 1944. In 1956, he was appointed director of the Division of Neurology in the Department of Medicine which included a 120-bed major residency training program.

Dr. Randt is the author of numerous medical articles and has made fundamental neurophysiological contributions in the understanding of sensory systems in man and animals and the effects of anesthesia on the brain. He is vice president of the Aerospace Medical Association, a fellow of the American Academy of Neurology, an associate of the Harvey Cushing Society, and a member of the American Neurological Association, American Medical Association, Society of Experimental Biology and Medicine, and Sigma Xi.

Dr. and Mrs. Randt (the former Mary Louise Mitchell) and their three sons have been making their home at 21300 Claythorne Rd., Shaker Heights, Ohio.

(Slide No. 1:)

ROLE OF LIFE SCIENCES IN THE NATIONAL SPACE PROGRAM

I. Man's contribution to successful space flight missions and his role as a scientific observer in space exploration.
II. Biological investigations:
  A. Effects of space environment on living organisms.
  B. Search for extraterrestrial life:
    1. Origin of life.
    2. Evolution of life in the universe.

Dr. RANDT. Those who have considered the role of the life sciences in the space program have generally accepted these two areas as being of greatest importance. The first has to do with man's contribution to successful space flight missions and his role as a scientific observer in space exploration.

The second has to do with biological investigations: The effects of space environments on living organisms, and the search for extraterrestrial life. This latter category bears upon the problems having to do with the origin of life and evolution of life in the universe.

On March 1, 1960, the Office of Life Sciences Programs was established in NASA and we have adopted these two general objectives; first, the implementation of manned space flight and exploration; and secondly, the biological investigations. We have chosen to separate the categories under these dual objectives into biotechnology and the basic medical and behavioral sciences, these having to do with manned space flight.

(Slide No. 2:)

OFFICE OF LIFE SCIENCE PROGRAMS OBJECTIVES

I. Implementation of manned space flight and exploration:
  A. Biotechnology.
  B. Basic medical and behavioral sicences.
II. Biological investigations:
  A. Effects of space and planetary environments on living organisms.
  B. Organic chemical investigation for evidence of extraterrestrial life.
  C. Search for extraterrestrial life forms.
  D. Contamination problems.

Dr. RANDT. Under the biological investigations: First, the effects of space and planetary environments on living organisms; secondly, organic chemical investigations for evidence of extraterrestrial life; thirdly, the search for extraterrestrial life forms; and fourthly, contamination problems.

Manned space flight and exploration are conceived to utilize man's unique capabilities for selecting and making a wide variety of unprogramed observations, for his ability to react intelligently to unanticipated situations for purposes of decisionmaking, and for his resourcefulness and manual skill in servicing the complicated mechanisms of space vehicles in flight.

These are indispensable contributions to the successful execution of space missions and to obtaining maximal scientific information, not only related to biological problems, but to the physical sciences as well.

The leadtime necessary for advances in biotechnology, requires a continuing vigorous effort. I have here listed the various areas of

activity in biotechnology. First manned machine integration and instrumentation; secondly, environmental stress tolerance and adaptation; thirdly, protective equipment, including radiation shielding and escape devices; fourthly, life support systems; fifth, crew performance; and sixth, public health problems, including ground crew safety.

(Slide No. 3:)

IMPLEMENTATION OF MANNED SPACE FLIGHT AND EXPLORATION

A. Biotechnology:
   1. Man-machine integration.
   2. Environmental stress tolerance—heat, acceleration, etc.
   3. Protective equipment and escape devices.
   4. Life support systems.
   5. Crew performance.
   6. Public health problems—ground crews and general.

B. Basic medical and behavioral sciences:
   1. Cardiovascular physiology.
   2. Respiratory physiology.
   3. Metabolism and nutrition.
   4. Neurophysiology and psychology.

Dr. RANDT. We recognize the military laboratories' outstanding capability in this area and we will expect to utilize it to the fullest extent.

As space flights become voyages of weeks or months' duration, research designed to acquire basic medical and behavorial information relevant to meeting the physiological and psychological needs for long-term existence and effectiveness in stressful, artificial environments, will necessitate augmentation of investigations in radiology, metabolism, respiratory physiology, cardiovascular physiology, neurophysiology, and psychology.

I have listed these various categories under the basic medical and behavorial sciences.

Basic biological studies concerning the effects of space environments on living organisms and the search for extraterrestrial life anticipate studies of molecular control of cellular activity and of comparative biology on the broadest possible scale. Exposure of living cells and tissues to a broad range of ionizing radiation, weightlessness, high vacuum, extremes of temperature, and unusual compositions of remote planetary atmospheres and surfaces opens a new window for observation of hitherto unexplained biological phenomena.

(Slide No. 4:)

BIOLOGICAL INVESTIGATIONS

A. Effects of space and planetary environments on living organisms:
   1. Radiation.
   2. Weightlessness.
   3. Low atmospheric pressure, temperature extremes, electromagnetic fields.
   4. Unusual composition of planetary atmospheres and surfaces.

B. Organic chemical investigation for evidence of extraterrestrial life:
   1. Chemical analysis of meteorites and other samples from space.
   2. Spectroscopic analysis of Earth and other planets for organic compounds.
   3. Automatic analysis by instruments of remote planetary surface and subsurface organic compounds.

C. Search for extraterrestrial life forms:
1. Terrestrial atmospheric microbial content (balloons, sounding rockets).
2. Automatic instruments for identification of remote life forms.
3. Methods for collection of samples and return to Earth.

D. Contamination problems:
1. Pollution and infection.
2. Extraterrestrial and terrestrial possibilities.
3. Indications and methods for decontamination.

Dr. RANDT. Although these studies will be an outgrowth of continuing ground-based investigations, the space environment provides a new laboratory which cannot be duplicated on Earth.

Recognition of these twofold objectives gave rise to the appointment of the Bioscience Advisory Committee by NASA Administrator T. Keith Glennan, in July 1959. The membership of this committee was selected on the basis of the generally recognized stature of the individuals, rather than prior interest in the national space program. It was chaired by Dr. Seymour S. Kety, Director of the Clinical Science Laboratory of the National Institutes of Health, and included Dr. Wallace O. Fenn, professor of physiology, University of Rochester; Dr. David R. Goddard, director of the Division of Biology, the University of Pennsylvania; Dr. Donald G. Marquis, professor of psychology, MIT; Dr. Robert S. Morison, director of natural and medical sciences, the Rockefeller Foundation; and Dr. Cornelius A. Tobias, professor of medical physics, University of California.

The Bioscience Advisory Committee was apprised of aviation medical facilities, programs, and personnel by 17 representatives of the Army, Navy, and Air Force, who comprehensively covered activities in this area. Representatives of industry and universities also provided background information for the Committee. Their report was submitted to Dr. Glennan on January 25, 1960, and its contents are now available to all those who are interested in this phase of the space program. This document reflects the considered opinion of six eminent individuals regarding the role of biology, medicine, and psychology in the NASA program. The recommendations have provided overall guidelines for the Office of Life Sciences which will be useful in further planning and development in this area.

The Committee was well aware of the excellent contributions being made by the military aviation medical laboratories and the desirability of avoiding unnecessary duplication in this area. Important as the aviation medical contributions have been and will continue to be, additional opportunities in biology, medicine, and psychology, are being presented in these fields related to the expanding space effort on a long-range basis. It is the purpose of the NASA Office of Life Sciences to augment the outstanding work of the military aerospace laboratories in order to provide basic contributions in space exploration.

(Slide No. 5:)

LIFE SCIENCES PROGRAMS

I. Planning and participation—future manned space flight missions.
II. Initiation of a planned program of biologic experiments in the upper atmosphere and space environment.
III. Grants and contracts in support of the NASA objectives in the life sciences.
IV. Planning a life sciences research center.

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Dr. RANDT. This slide illustrates the four major categories in which we plan programed activity for the next year. The first is that of planning and participating in future manned space flight missions. We anticipate no change in the organization or operation of the Project Mercury. This is a top priority space effort, and we will certainly endeavor to provide the best possible support that we can to this project from our office.

Manned space exploration brings to the fore new problems which are essentially different and of another order of magnitude from those of conventional high-altitude, high-speed flight. The effects of ionizing radiation, weightlessness, and long duration existence in an isolated, confining, artificial environment will require further mobilization of the talents of those who can contribute in the medical schools, industry, and other Government agencies as well as in the military services. To the greatest practicable extent, it is the intention of NASA to utilize the personnel and facilities of groups qualified by training and experience to contribute in these areas of research.

The second major program is that of the initiation of a planned program of biologic experiments in the upper atmosphere and space environment.

The space environment presents a new dimension or observation of biologic phenomena. The ultimate goal is the identification and study of life elsewhere in the universe. This accomplishment would lead to knowledge pertaining to the origin of life and its evolution, thereby adding significantly to the understanding of the fundamental laws of nature concerned in life sciences.

The present state of space technology directs attention to objectives somewhat less in depth and scope, but nonetheless deserving of concerted effort by the biological and medical scientific communities. These experiments fall into two general categories: First, those having to do with survival and performance—these studies to be conducted in animals and in man in the space environment. Secondly are the biological investigations at a cellular or subcellular level, down to the molecular level.

It is imperative that the hazards of space flight be tested with animals prior to subjecting men to this experience. Brief duration exposures of animals in nosecones flying a ballistic trajectory and the Earth-orbiting Sputnik II, in which a dog was said to have lived for several days, have produced no short-term evidence that space flight is incompatible with survival.

The radiation trapped in the geomagnetic field, cosmic rays, including high-energy heavy primaries, and the proton flux associated with solar flares have been incompletely studied. Such physical measurements as now are available and many of those planned for the future are difficult or impossible to translate in terms of the relative biological effectiveness of the radiation. These determinations are necessary in order to assess whole body and organ or system effects, as well as the implications regarding genetic alterations and longevity, including possible vascular damage and carcinogenesis.

Basic biological effects of the ionizing radiations in space which cannot now be reproduced on Earth should be determined at a cellular and molecular level.

It is essential that measurements be taken simultaneously with instruments and with biological assay on cells, tissues, and animals before exposing man to these hazards. Weightlessness represents a unique opportunity for determination of its biological and behavioral effects in the space environment.

Such studies should range from the possible physico-chemical alterations in life processes which could affect fertilization, reproduction, growth, morphogenesis, and genetic mechanisms—to the performance of animals and men subjected to removal of the constant stimulation of specialized bodily sensors by the force of gravity.

Cardiovascular effects from altered distribution of blood flow to vital organs including the brain, heart, and kidneys as well as the neurological consequences of reduced sensory input as its affects regulatory systems and the mind are of interest and importance. No satisfactory data are presently available as to the possible effect of weightlessness on performance.

Inflight tests of life support systems with regard to their adequacy, efficiency, and reliability in maintaining an artificial environment for animals should certainly precede trials with humans. Inflight experiments offer an opportunity to assess the results of combined stresses which cannot be reproduced on Earth. Emphasis should be placed on the acquisition of knowledge throughout the range of animal activity from survival, tissue damage, genetic and longevity effects, reversible changes with decrement in performance, and means of improving well-being and capability of both animal and human subjects.

Biological studies in addition to those principally concerned with radiation and weightlessness should include observations of the effects of high vacuum, temperature extremes and unusual combinations of elements in planetary atmospheres and surfaces. The latter investigations can be substantially enhanced by spectroscopic studies directed toward more precise identification of extraterestrial life supporting organic chemical compounds.

The next step would logically involve the development of instruments for use in flight and in planetary landings, to identify and to analyze extraterrestrial organic compounds and life forms. Recovery of such information would depend upon telemetry for relay to Earth-bound or satellite receiving stations. Development of automated instruments for collection of samples to be returned to Earth for analysis would be the penultimate achievement second only to placing human scientific observers on a planet.

The long leadtime, expense, and competition with physical science experiments requires expeditious planning and judicious execution of a sound program involving biological and medical experiments in the space environment. Such matters are the immediate concern of the NASA Office of Life Sciences Programs.

Thirdly, we wish to institute a program of sponsored research by grants and contracts in support of the two major objectives of the Office of Life Sciences Programs. We anticipate that at least three-quarters of our budgeted funds for the Office of Life Sciences Programs will be devoted to this sponsored grant and contract porgram.

(Slide No. 6:)

LIFE SCIENCES RESEARCH CENTER

I. Objectives.
II. Justifications.
III. Disciplines and organization:
  A. Flight medicine and biology.
  B. Space medical and behavioral sciences.
  C. Space biology.

Dr. RANDT. Fourthly, there is the planning of a Life Sciences Research Center. In order to attract and productively utilize the talents of individuals with outstanding scientific potential who will form a small but high quality nucleus of capability for leadership and integration of a national program, it is essential that an inhouse facility be developed. Although it is anticipated that the major portion of the NASA Life Sciences Program will be conducted through grants and contracts with universities, industry, and the military services, individuals of sufficient stature and a full-time interest will be indispensable in establishing and maintaining an appropriate degree of active participation with the physical scientists and engineers in the other operating divisions of NASA.

A facility in which this personnel complement will productively pursue their relevant interests will concentrate on what we have chosen to call flight medicine and biology. This has to do with the planning and programing of biological and medical experiments in flight, and secondly, with the design, construction, assembly, and testing of space craft in which these experiments might be conducted.

You will note that in this applied section of our proposed research center we do not include biotechnology. In this area we will look to the military service laboratories for support.

Secondly, we will have representation in the space medical and behaviorial sciences—this, then, in neurophysiology and psychology, metabolism, radiology and cardiovascular respiratory physiology. Thirdly, we will pursue space biology. These are ground based investigations having to do with molecular biology, cellular and environmental physiology, and those areas which are concerned in the determination of extraterrestrial life and the avoidance of contamination—either contamination from the Earth to the Moon and planets, or at a later date the avoidance of contamination in such samples as might be returned to Earth.

This emphasis in these three categories will assure no conflict of interest with the existing aviation medical laboratories in the military services, or with their outstanding competence in biotechnology.

(Slide No. 7:)

RELATIONSHIP OF NASA LIFE SCIENCES TO OTHER AGENCIES OF THE FEDERAL GOVERNMENT

I. Department of Defense:
  Office of Defense Research and Engineering.
  Office of Science.
  Technical Advisory Group for Bioastronautics.
II. National Science Foundation.
III. Department of Health, Education, and Welfare:
  U.S. Public Health Service.
  National Institutes of Health.
IV. Atomic Energy Commission: Division of Biology and Medicine.
V. Federal Aviation Agency: Bureau of Aviation Medicine.

Dr. RANDT. The NASA Office of Life Sciences Programs has established liaison with the military efforts in this field through the Office of Defense Research and Engineering in the Department of Defense.

Triservice representation in bioastronautics has been brought together in this office under the Director of Science for joint consideration of future plans and for consideration of transfer of funds, when necessary, to directly support appropriate proposals from the Army, Navy, and Air Force laboratories.

We also recognize an important interface with the National Science Foundation, and we have established informal liaison with Dr. John T. Wilson, Assistant Director of the Biological and Medical Sciences of the National Science Foundation in this regard.

We have additionally established informal liaison with the Office of the Surgeon General of the United States Public Health Service, the National Institutes of Health, the Atomic Energy Commission, and the Federal Aviation Agency.

The NASA Office of Life Sciences Programs has been established to provide a focal point for activities in this area on a national and international scale. It is the well-defined purpose of the office to augment desired current programs and to supply the impetus for further life sciences contributions in space exploration.

Thank you.

The CHAIRMAN. Thank you very much, Dr. Randt.

May I ask you a question or two. Where is your work being centralized at this time?

Dr. RANDT. At this time, Mr. Chairman, we are in the process of organizing our office and recruiting the key personnel. We have no inhouse, working competence in this area at the present time.

The CHAIRMAN. From where are you operating to organize the office?

Dr. RANDT. From the headquarters of the National Aeronautics and Space Administration.

The CHAIRMAN. Here in the District of Columbia?

Dr. RANDT. Yes, sir.

The CHAIRMAN. Now, at this time you have no center set up. You are organizing the Life Sciences Center, aren't you?

Dr. RANDT. We are organizing the Office of Life Sciences Programs in order to execute programs in the four areas that I have outlined, one of which is the planning of a research center.

The CHAIRMAN. Research Center for Life Sciences?

Dr. RANDT. Yes, sir.

The CHAIRMAN. And where do you envision that center to be located?

Dr. RANDT. No firm commitment has been made on this.

The CHAIRMAN. How large a project will it be?

Dr. RANDT. This, again, is now in the process of being formulated. The overall guidelines for this effort were provided in the Kety report. There it was suggested that this should include in the neighborhood of 60 professionals.

The CHAIRMAN. What report do you say that refers to?

Dr. RANDT. The Bio-Science Advisory Committee report chaired by Dr. Seymour Kety.

The CHAIRMAN. Yes. So you really are just getting organized, aren't you, in NASA in reference to life sciences?

Dr. RANDT. This office was established as of March 1, 1960, and that is correct, sir.

The CHAIRMAN. How fast do you expect to proceed?

Dr. RANDT. As rapidly as possible.

You refer now particularly to the research center area?

The CHAIRMAN. Yes, and to your whole program of developing life sciences.

Dr. RANDT. Well, we are proceeding at the moment. Would you care to have me describe our activities?

The CHAIRMAN. I think you have generally covered them fairly well, but you don't give us any idea of the cost of such a project or the program under which you are proceeding to develop the project as, perhaps, what its overall cost may be in the next 12 months, say. Sixty scientists, would that be 60 individuals——

Dr. RANDT. Sixty scientists.

The CHAIRMAN. Sixty scientists.

And you would cover the subjects of biology, physiology, and medicine in the center?

Dr. RANDT. Yes, sir.

The CHAIRMAN. I think perhaps you covered some additional subjects of a technical nature there?

Dr. RANDT. Some engineering.

The CHAIRMAN. Engineering, would that be covered, too, in the center?

Dr. RANDT. Yes, sir.

The CHAIRMAN. It would all be built around the subject of space?

Dr. RANDT. Yes, sir.

The CHAIRMAN. But in developing these subjects on life sciences you must necessarily range pretty far out, must you not, because you are trying to develop life sciences insofar as travel is concerned, and also life sciences insofar as needed in other celestial bodies?

Dr. RANDT. We are striving to set this up as a long-range program.

The CHAIRMAN. In doing that are you expected to cooperate with the Air Force, the Navy, and the Army, and the other establishments that may have a program of a similar character?

Dr. RANDT. We certainly do expect to do so and our relationships have been very satisfactory since the establishment of this office. We have had a maximal amount of cooperation.

Mr. MOELLER. Will the chairman yield?

The CHAIRMAN. Mr. Moeller.

Mr. MOELLER. I would like to ask, Doctor, if similar programs are now being carried on by the Air Force, Army, Navy, et cetera, why could not NASA work jointly with all of these in their home programs, because eventually it is about the same thing that you are going to be striving for? What is the necessity of setting up a separate research center just for NASA?

And while you are thinking of the answer to this, let me probe further into this: You said you need something now in the way of the life sciences, and you made reference to the fact that there would be some liaison with NIH. I don't know what all you are proposing to do, but with the fabulous institution this Government has there

at NIH would it not seem most reasonable that this could be carried out through NIH, at least the portions that you will need in space medicine? And then, secondly, over against the need for an engineering research, one of these days this Government is going to have engineering research spots in every State of the Nation, and many, many of them.

Why can't we take some existing research institution and apply the things that you are to seek?

Dr. RANDT. In answer to the first part of your question, I would like to emphasize again that we intend to cooperate to the fullest extent with the military service efforts in this area. As I pointed out in my previous remarks, we recognize great strength in these laboratories under the category called biotechnology. This includes the stress tolerance and adaptation, life support systems, protective equipment, and escape devices, crew performance, and man-machine integration and instrumentation. This is a very important area of activity. I think, however, there are two other major areas, the first being the basic medical and behavioral sciences. I think it is generally recognized that the potential in this area lies in major part in our medical schools. This is not to say that there are not some outstanding scientists in this area in the miliary service laboratories, but the major potential, I believe that is the consensus of opinion, that this lies in our medical schools.

If this be a national program we desire to use the national potential to promote it.

In the basic biological investigations, I think that there, again, the potential lies in our universities, and we wish to utilize this potential to the fullest extent.

As I described our program perhaps I did not emphasize adequately that we wish to have a small hard core of high quality people to provide leadership for this program. We recognize what you say about the activities of the NIH, and other places, and we would then only wish to provide the leadership, not do a major or any significant amount of the work inhouse. We need inhouse competence to provide leadership.

As regards the engineering, this is a segment of engineering generally referred to as bioengineering or human factors, and is a small part of the overall engineering type effort.

The CHAIRMAN. I think your explanation is very timely. But, now, take NIH, for instance, you would not expect that agency of the Government to deviate from its major role of taking care of diseases like heart and cancer, and get off into a program of space medicine, that is, the effects of weightlessness, say, and the effects of gravity in another environment, those things, without special direction from the Congress, would you?

Dr. RANDT. We certainly would not, Mr. Chairman.

The CHAIRMAN. I don't think those people out there would wish to do it without direct instructions from the Congress. I think they are doing a superb job there, but, on the other hand, would you not say this, Doctor, that this program should accept from NIH and other agencies all of the available experience that they have which could be applied to your problems in life sciences?

Dr. RANDT. I would most certainly agree with that.

The CHAIRMAN. Certainly I favor very much the idea advanced by Mr. Moeller that we use our medical institutions of learning throughout the United States to the maximum extent in the furtherance of this effort.

Now, why is it your program does not cover, say, aeronautical medicine?

Dr. RANDT. No; I think that aviation or aeronautical medicine is very well covered in the military service aviation medical laboratories.

The CHAIRMAN. But not insofar as civilian aviation is concerned. I would assume that the principles are the same, just as I would assume that the principles of the life sciences in space would be similar, certainly, or almost identical in military and nonmilitary applications; isn't that right?

Dr. RANDT. I believe so.

The CHAIRMAN. And it does seem to me—of course in certain quarters I can't use the term "aerospace"—but it does seem to me that your problems are going to be connecting and coordinating and even closer than that in your life sciences as to aeronautics and astronautics?

Dr. RANDT. Yes, sir; we recognize this, and it is one of the reasons we have kept in close touch with the Federal Aviation Agency.

The CHAIRMAN. Yes; under the law, NASA has considerable jurisdiction over aeronautics. I am not going into that question now, but it is in there, and it is in the bill we put through the Congress last week; it is specifically there. So you do have an obligation there as well as does the FAA.

Dr. RANDT. Yes, sir; and we would like to provide leadership for that, but have the actual work be conducted in the existing facilities.

The CHAIRMAN. I think you should provide more than leadership. It seems to me you should provide direction, too. Of course, that might be considered a portion of leadership, but direction, in order that you move toward the goals that you have in mind, or have established. Leadership alone, I don't think, is going to do the job without planning on the part of NASA and your Life Science Center; is that right?

Dr. RANDT. Yes, sir.

Mr. MOELLER. Will the gentleman yield?

The CHAIRMAN. Yes.

Mr. MOELLER. I should like to ask where you expect to find these 60 hard core scientists? Where are you going to look for them?

Dr. RANDT. Inasmuch as we do not include the biotechnology area, I think we will not look to the military services for these people. We would expect that they would come from the universities, private research institutes, and industry.

The CHAIRMAN. Mr. Daddario?

Mr. DADDARIO. I have a few questions, Mr. Chairman.

How will the work of this group of people you are putting together differ from the objectives that are now within the jurisdiction of the Department of Defense?

Dr. RANDT. We will concentrate, Mr. Daddario, on areas other than the biotechnology, which is heavily represented and very well represented in the Department of Defense laboratories. We will concentrate on, first, biologic experiments in space, the planning and programing, the design, construction, testing of spacecraft, to promote

these experiments; second, the basic medical and behavioral sciences; third, the basic biological areas. In all three categories this capability, as far as I know it, is not represented in great depth in those laboratories. There are some outstanding scientific efforts going on, and we recognize those, but, again, if this be a national program we wish to use the national potential.

Mr. DADDARIO. When you say that it is not in great depth, you admit that there is the beginning of activity in this area?

Dr. RANDT. I would not only admit it, I would recognize it wholeheartedly.

Mr. DADDARIO. And since this is, is it not, an elongation of the activities of the Department of Defense has had over a course of time, wouldn't it be better to build up the depth in this area rather than do it in an entirely new field where you will be starting from scratch?

Dr. RANDT. I do not believe this is an elongation of what has been going on in the military services, Mr. Daddario.

Mr. DADDARIO. Well, I have looked through some of the testimony in the past, and Dr. Glennan at one time said, referring to the Department of Defense:

> They won't know where to start. They know what to do, and they have no more to do as aircraft have become faster and have flown to greater heights. They have had to qualify their pilots. They have had to provide the kind of environmental training and to determine the degree to which a pilot can withstand unusual stresses. This I think will continue right through into the astronautics field. But in the broad sweep of the life sciences I think there isn't any question but someone has to do this, and we believe that we can't duck that responsibility.

And he said, adding to that:

> We have not been concerned to any great extent with really basic studies of the biological type, and we must get into this area.

Somewhere else in the course of the testimony Dr. Glennan stated that he didn't believe that—well, he said something that they could not handle the responsibilities of deep probes into space.

Now, do you believe that that is a correct analysis of the situation, that the Department of Defense could not, upon its present capacities, build up, also, the capacity to take care of our national problems as we emerge into the space area insofar as what we must do to preserve life in outer space?

Dr. RANDT. I would not say that it could not be done, however, I believe the answer to this lies in the Space Act of 1958 which clearly gives the mandate in this area to the National Aeronautics and Space Administration.

The CHAIRMAN. Will the gentleman yield?

Mr. DADDARIO. Yes, Mr. Chairman.

The CHAIRMAN. What concerns me now: We have the military there—and I was on Armed Services when we set that up in San Antonio, we amended the bill to put it in. It seemed to me it was needed, someone to begin it at that time. But now we have the FAA coming in, the Federal Aviation Agency. It seemed to me rather than having a military program, and then one under FAA, we ought to have a unified program; that is true.

It seemed to me, over the long pull, the committee, the Congress, and the country are going to have to decide where the unified program would be. What would you say to that?

Dr. RANDT. May I speak to that, please?

The CHAIRMAN. Yes.

Dr. RANDT. I think that in the life sciences area my experience to date has indicated that at a working level we will have a very well-integrated program with the military services, the FAA, and NASA.

The CHAIRMAN. The FAA is just beginning on their program, isn't it?

Dr. RANDT. Yes, sir.

The CHAIRMAN. That puts an additional program, and there is no present unified control there. So you have peacetime programs under FAA, you have a peacetime program under NASA, and you have military programs in the three services. That is correct, isn't it?

Dr. RANDT. Yes, sir.

The CHAIRMAN. Thank you for yielding.

Mr. DADDARIO. I also questioned Admiral Hayward on this and I asked him this question:

Referring to the recommended amendments to the Space Act, who would decide or who should decide whether or not NASA should also get into the field of aerospace medicine?

Admiral Hayward replied:

I would say offhand that they should not get into it. The Department of Defense will do any of the aerospace medicine that they need. There are people involved, and we have the people and the facilities and the doctors involved in the work both in the Air Force and in the Navy and in the Army. I think that the decision between the Secretary of Defense and Dr. Glennan would be that the Department of Defense would do it, that NASA would not get in it.

Now, why do you disagree with Admiral Hayward's position?

Dr. RANDT. I certainly don't wish to disagree with Admiral Hayward, but I again would point to the Space Act of 1958. In section 102(c) it is very clearly stated there that the National Aeronautics and Space Administration shall be responsible for the development and operation of vehicles capable of carrying living organisms and I think that this has been the responsibility already delegated to the NASA.

Mr. DADDARIO. Then, as I understand it, with your interpretation of the act you would feel that that would be a requirement upon NASA to take away from people who have developed a capacity and the facilities, and that the act does not carry within it the implicit idea that you would use what already exists? And is it your position that the act is so worded that you cannot use and should not use existing facilities, and that if the requirements that NASA has insofar as the Space Act is concerned could be carried out by passing their requirements to the Department of Defense, that they should not use these capacities, and that if they did use them it would be an abrogation of their responsibility under the Space Act?

Dr. RANDT. We have no intention of taking anything away from anyone. We merely wish to fulfill our responsibilities given by law in this area. My previous remarks here, I believe, have indicated that we intend to and will utilize the present personnel, facilities, and programs to a maximal extent.

Mr. DADDARIO. I won't continue to quote people, but General Schriever and many others, in whom I have great faith, have felt that the Department of Defense has the present capacity to take care of

the requirements in this field, and that they have the capacity for future requirements. I have not as yet been convinced that we should not carry out our space responsibilities by the utilization of facilities. I am concerned with the expenditure of funds in this area, with the proper utilization of personnel now in existence, and the future prospects of these people who have developed programs within the Department of Defense. So far as their ideas of the future are concerned, if they are not allowed to grow properly into the fields which they have developed in the past, it will be very unfortunate. The Department of Defense, I think, has shown that it has stayed pretty well ahead of the present mechanical requirements, always projecting thoughts into the future.

This being the case, I think that you would have to make a very strong case in order to set up any other requirement within NASA beyond that of establishing the proper liaison wih the Department of Defense so that it could carry out your requirements. If the requirements could be done in this way it would be cheaper, it would be more efficient, and it would be the proper utilization of existing personnel.

Now, this is my point of view, this is how I see it at this stage of the game. I would like you to tell me why it could not be done in this way and should not be?

Dr. RANDT. I wonder if I might first ask you a question. With whom would you set up the liaison in the NASA?

Mr. DADDARIO. I don't think it would be a very difficult proposition to let NASA have a small staff of people who were qualified in this area, who would know what they would expect of a space vehicle, and the men who would go in it, and that they would get together with the Department of Defense along proper channels. A paper could be drawn within which the requirements would be set out, and the Department of Defense would carry out these requirements, and there would be proper contact from time to time to see that this was being done.

I don't see that this would be any more difficult than setting up liaison within your own department. NASA is growing and growing, and as it grows you are going to have to have some kind of coordination anyway. This would simply be coordination along the same lines.

Dr. RANDT. Mr. Daddario, this is precisely what we are trying to set up within the NASA, a very small group of competent people who can perform this function which you have outlined, and a very logical one.

Mr. DADDARIO. And you are starting off with 60 scientists.

Dr. RANDT. We are not starting off with 60 scientists by any means.

Mr. DADDARIO. Is that your aim?

Dr. RANDT. This is an aim for the future, 4 or 5 years from now.

The CHAIRMAN. Will the gentleman yield?

Mr. DADDARIO. Yes, Mr. Chairman.

The CHAIRMAN. We had a similar situation to this in the matter of translations, where 5 or 6 agencies are in the act. Now, we made a recommendation in the report, which in this case I think we could very well make a recommendation.

The question in my mind is this: Should you start civilian medical research in NASA, or FAA? You have FAA getting into the act

now, too. They may have full authority but it does seem to me that the principles involving high-speed flight in the air, and the principles involved in space will be, in many instances, identical, and they certainly are correlated subjects. And whether there would be a further breakdown of having a peacetime agency doing part of the work and military doing the other part, and NASA doing the other part, brings in many problems.

Do you want to comment on that, Doctor?

Dr. RANDT. No, sir.

The CHAIRMAN. All right.

Mr. DADDARIO. Doctor, would these 60 scientists whom you are shooting for, would they be doing some inhouse activities, themselves?

Dr. RANDT. Yes; this would be the reason for obtaining them, to provide internal competence for leadership and direction.

Mr. DADDARIO. Then once you started this and once you had experiments going on within NASA, wouldn't there be a tendency, as there always is, for this to continue to grow and build up, and wouldn't this detract from the effort in the Department of Defense, and wouldn't it lead to duplication and wouldn't you find that you would be having experiments of the same kind going on in two different places, and wouldn't it also be an inefficient use of competent personnel in this area?

Dr. RANDT. I don't believe so, Mr. Daddario. We wish to have internal competence to provide leadership. And in order to have internal competence you must give people a place to work. You don't develop and maintain internal competence by entirely deskwork, administrative work. One must actually participate in these problems at a working level in order to maintain the competence.

Mr. DADDARIO. I am sure you don't imply there is lack of leadership in the Department of Defense insofar as their aerospace medicine is concerned?

Dr. RANDT. I certainly do not, but as I pointed out, the law has given us this mandate, and we wish to fulfill this responsibility.

Mr. DADDARIO. This is your only reason for saying apparently that you cannot use the facilities and the capacity which now exists within the Department of Defense, that because you have this responsibility under the Space Act that it would be improper to set up the machinery which would have you carry out this responsibility by the use of existing personnel and equipment and capacities?

Dr. RANDT. Mr. Daddario, I did not say that we could not use what is going on in the Department of Defense. Quite to the contrary we expect to do just this as I have repeatedly stated.

Mr. DADDARIO. But you do say, pardon me, Doctor, but you do say that you cannot use these facilities because the Space Act gives you the requirement to carry out this responsibility. And I ask you, aren't you carrying out this responsibility if you pass over your requirements to the Department of Defense, as long as they are capable of doing the job and expanding their capacity to take care of your future requirements?

Dr. RANDT. I don't know how I can make it more clear that I do not wish to indicate, and never have said that we cannot make use of this capacity. We intend to make use of it to the fullest possible extent.

The CHAIRMAN. Any further questions?

Mr. DADDARIO. One further question.

But when you say that you intend to make use of it to the fullest possible extent, do you believe that to go with that you have to build up a facility and an inhouse capability of your own?

Dr. RANDT. I believe that we must have some internal competence in order to establish this liaison of which you speak, which I believe is highly desirable.

Mr. DADDARIO. And you do disagree, then, with Admiral Hayward, and the others, who have felt that NASA should pass their requirements over to the Department of Defense in this field of aerospace medicine?

Dr. RANDT. I have other beliefs on these subjects, as I have previously stated.

Mr. DADDARIO. This is all, Mr. Chairman.

The CHAIRMAN. Mr. Bass, do you have any questions?

Mr. BASS. No questions.

The CHAIRMAN. Dr. Sheldon, do you have any questions?

Dr. SHELDON. Dr. Randt, you probably are not in a position today to give us any kind of firm figures on the cost of the program, since it is still in formulation. We shall probably have to wait for the budget estimates of next year.

Can you give us any clue as to order of magnitude, at least, as to what kind of a capital investment might be entailed in this center, and what kinds of program costs you might have in the life sciences area for inhouse and for external contract work?

Dr. RANDT. We are talking in terms of approximately 60 professionals, the requirement for such a number of individuals would be in the neighborhood of 90,000 square feet. This would have roughly an approximate cost of $3 million. These plans, as I have stated previously, are in the process of formulation, and I would like to make it clear that this is just an overall estimate that has not been completely worked out by any means.

The CHAIRMAN. Do you have any further questions?

Dr. SHELDON. Not at this time, sir.

The CHAIRMAN. I think that covers it pretty well.

Mr. Moeller?

Mr. MOELLER. There is still one question: How did you arrive at the figure of 60?

Dr. RANDT. We discussed it in detail with those 6 eminent scientists which I named previously. There were 3 categories in this research center where we would like to promote our efforts. The problem was then discussed in terms of what they call a critical mass: This indicates the number of people that generally interact with one another and require maintenance support to do a reasonably good job in a number of scientific areas.

So each critical mass was 20, and we multiplied that by 3.

Mr. MOELLER. Would you feel that this thing would be developing, that you would soon have 90 and maybe 120?

Dr. RANDT. I do not believe so, Mr. Moeller, I sincerely do not believe so.

Mr. MOELLER. You mentioned before you would get this staff from some of the teaching profession, some of the industries, and so forth and so on.

Dr. RANDT. Yes.

Mr. MOELLER. The teaching profession, of course, has been one of our great concerns because we are losing many, many extremely capable teachers to industry, and so forth.

Now, there doesn't seem to be any other area you can go to, is there? Is there any plan to start out in some of our graduate schools to pick out competent young fellows and train them along the lines in which you feel they ought to have specific training and maybe produce your own staff, rather than to choose from existing staffs?

Dr. RANDT. We are very much concerned with this problem of education and training. We hope to have such a program, a fellowship program, to develop our own scientists.

Mr. MOELLER. You think we may be robbing some of our schools of those much needed instructors presently, do you?

Dr. RANDT. I don't believe so.

Mr. BASS. Mr. Chairman.

The CHAIRMAN. Mr. Bass.

Mr. BASS. Doctor, if NASA does set up separate facilities for space medicine, there will be duplication between your facilities and, as I understand it, what is already set up in the Department of Defense, is that not true?

Dr. RANDT. No, sir; I don't believe so. I have tried to describe this in detail. There is no such duplication.

The CHAIRMAN. May I say this: The Doctor has said his hard core of experts would be largely directional for leadership purposes in the field of space rather than for duplication. Is that correct?

Dr. RANDT. That is correct, sir.

The CHAIRMAN. Thank you very much, Doctor, we appreciate your fine statement.

The next witness we have this morning is Lt. Col. Richard R. Taylor, Chief, Research Division, Medical R. & D. Command, Office of the Surgeon General, Department of the Army.

Although administrative changes have pushed the Army out of important parts of the space program, the several technical services still have important supporting capabilities, and Colonel Taylor will discuss those in the medical field.

I have Colonel Taylor's prepared statement here, and I think the other members of the committee have, too.

I might say also that the colonel was born in Iowa on November 21, 1922. He has a bachelor of science degree, from the University of Chicago, doctor of medicine degree in 1946 from the University of Chicago. He was ward officer, general medicine, Army-Navy General Hospital, 1947 to 1951; company grade medical officer, Walter Reed Army Institute of Research, 1951; had a residency, internal medicine and cardiology, Letterman Army Hospital, 1951 and 1952.

He has a great deal of experience. I will not take the time of the committee to read it, but I think we should place it in the record, so we will all know of Colonel Taylor's competence.

(The biography is as follows:)

LT. COL. RICHARD R. TAYLOR

Born Prairieburg, Iowa, November 21, 1922.

Bachelor of science degree, University of Chicago, 1944; doctor of medicine degree, 1946.

Military assignments: Basic medical officers course, Brooke Army Medical Center, 1947; ward officer, general medicine, Army-Navy General Hospital, 1947–51; company grade medical officers course, Walter Reed Army Institute of Research, 1951; residency, internal medicine and cardiology, Letterman Army Hospital, 1951–52; commanding officer, 7th Medical battalion, 7th Infantry Division, Korea, 1953–54; resident, pulmonary disease, Fitzsimons Army Hospital, 1955; Chief, Non-TB Chest Section, Fitzsimons Army Hospital, 1956–57; commanding officer, U.S. Army Medical Research & Development Unit, Fitzsimons Army Hospital, 1957–58; Deputy CO, U.S. Army Medical Research and Nutrition Laboratory, Fitzsimons Army Hospital, 1958–59; Chief, Biophysics and Astronautics Research Branch, U.S. Army Medical R. & D. Command, Office of The Surgeon General, Washington, D.C., 1959; present assignment, Chief, Research Division, U.S. Army Medical R. & D. Command, Office of The Surgeon General, Washington, D.C.

The CHAIRMAN. If you will, sir, we will be glad to have your prepared statement.

STATEMENT OF LT. COL. RICHARD R. TAYLOR, MEDICAL CORPS, CHIEF, RESEARCH DIVISION, OFFICE OF THE SURGEON GENERAL, HEADQUARTERS, DEPARTMENT OF THE ARMY

Colonel TAYLOR. Thank you, Mr. Chairman.

The complexities of human space exploration, particularly if long-time periods are involved, are of such magnitude that input data from the whole spectrum of basic biological and medical research is essential. The Army's medical research program is designed to protect the soldier, improve his mental and physical capacity and, when necessary, provide clinical treatment in the most stressful situation known to man—war. Fundamental knowledge gained from this entire program may well apply to the American conquest of space.

As you recall, in May 1959, the Army Medical Service, in cooperation with Navy medical scientists and the Army Ballistic Missile Agency, Huntsville, Ala., successfully recovered Able and Baker, two primates, following a missile flight. Since then, the Army Medical Service has continued to support the national space effort by providing a full-time medical officer to the NASA Space Task Force, Langley Air Force Base, Va., qualified psychologists to help in the training of chimpanzees in support of the NASA Mercury program, and various technical officers to support the National Research Council's Advisory Committee on Bioastronautics. In addition, Army medical officers have been named to participate in the recovery of the Mercury astronaut.

In selecting material to highlight my statement this morning, I have made every effort to select those research tasks which may have a direct and immediate application to the national space program. At our three largest inhouse medical research laboratories, current programs initiated in support of Army combat missions may well provide answers directly applicable to space.

At the Walter Reed Army Institute of Research, Washington, D.C., these include work on chemical protection against total body radiation. Our efforts are directed to the development of an antiradiation drug which can be taken before exposure, to reduce the biological effects of ionizing radiation. Such a drug would be of direct value in traversing the Van Allen belts.

In addition, the Division of Neuropsychiatry at WRAIR has an active program to determine the widespread effects of stresses on the

psysiological functioning of the soldier and the search for constructive means to modify these effects and thus prepare for a more effective performance.

Numerous university and industrial contracts support their efforts. At the Army Medical Research Laboratory, Fort Knox, Ky., special studies related to men's senses may be useful. Vision and perception tasks have been designed to gain knowledge on the adaptation of known human perceptual abilities. Audition and sound experiments to determine the limits and variations in psychological and physiological capabilities under a variety of noise environments are underway.

Finally, a task to study the basic physiological mechanism involved in cold adaptation may be of interest in the exploration of distant plants. The Medical Research and Nutrition Laboratory, Fitzsimons General Hospital, Denver, is the only Department of Defense Laboratory devoted to fundamental research in the medical aspects of nutrition. Studies related to the lowest level of nutrients at which the soldier can function effectively and the possible utilization of algae as a food source have been vigorously pursued with human volunteers.

The potential medical problems associated with future warefare are immense. Our current medical R. & D. effort, including facilities, qualified technical manpower, and funds, is directed to support programs designed to improve the combat effectiveness of the Army. Whenever research provides advances in basic knowledge or applications to space medicine, the scientific information will be made immediately available to American physicians responsible for our Nation's program of space medicine.

The CHAIRMAN. Thank you very much, Lieutenant Colonel Taylor.

It is a short statement, but it is to the point, and we appreciate that.

Where would you say the headquarters for this program in the Army is located now? Is it still at Huntsville?

Colonel TAYLOR. The Army does not have a program in space medicine, as I have tried to bring out in this short statement.

The programs which I have outlined which we consider to have some relevance to space are controlled from the Headquarters of the Medical Research and Development Command in the Surgeon General's Office and are primarily carried out at Walter Reed Army Institute of Research, at Fort Knox, and at Denver.

The CHAIRMAN. In these three centers?

Colonel TAYLOR. Yes.

The CHAIRMAN. But your headquarters are here?

Colonel TAYLOR. No, sir.

The CHAIRMAN. You don't have a separate program for space medicine?

Colonel TAYLOR. No, sir.

The CHAIRMAN. Do you have a program covering aeronautics?

Colonel TAYLOR. No, sir.

The CHAIRMAN. And the work you do is largely collateral to the normal work of the Surgeon General's office?

Colonel TAYLOR. That is correct, sir.

The CHAIRMAN. You are interested, according to your statement, in nutrition for soldiers' diets? In other words, the minimum nutrition needed?

Colonel TAYLOR. That is correct.

The CHAIRMAN. The best nutrition to maintain an efficient soldier and things of that sort—that is handled largely out at Denver?

Colonel TAYLOR. Yes, sir.

The CHAIRMAN. Now, the space aspects there—you refer to Able and Baker—what has come to my mind a number of times is why did we stop with sending two primates through space in a missile? Why did we stop with that? Why have we not followed through with any additional primates?

Colonel TAYLOR. It is my understanding that at that time, the Army Medical Service was offered the opportunity to participate on a space-available program with the Army Ballistic Missile Agency on the Jupiter 18 nose cone recovery. There was one further test shot in September and funds or programs could not be arranged to continue this program.

The CHAIRMAN. So we have had no additional experiments in reference to sending primates or any other animals aloft, have we?

Colonel TAYLOR. The Army does not, sir.

The CHAIRMAN. Do you know of any in existence, whether it be Army or otherwise?

Colonel TAYLOR. We have a number of our individuals cooperating with NASA in training programs related to Project Mercury. These are still in progress.

The CHAIRMAN. We have made one successful flight. The Army handled two monkeys in that instance, and yet after making the successful flight, we dropped the whole matter?

Colonel TAYLOR. Yes, sir.

The CHAIRMAN. Does that sound to you like reaping the ultimate benefits of your successful experiment?

Colonel TAYLOR. The Army Medical Service was directed by higher headquarters outside the Department of the Army to discontinue activity in this area.

(EDITOR'S NOTE: The order is believed to have originated in NASA.)

Mr. MOELLER. Will you yield, Mr. Chairman?

The CHAIRMAN. I yield.

Mr. MOELLER. Doctor, may I ask: You say you know of no instance where the Army has been continuing this, and you had been asked to discontinue.

Are you also unaware of any of the activities of any of the other branches of the military?

Colonel TAYLOR. No, sir, I am well aware of the Air Force research.

Mr. MOELLER. In other words, others are involved. It could have been a case of maybe this was assigned to the Air Force instead of the Army?

Colonel TAYLOR. Yes, sir. I am not prepared to comment on this aspect, and I am well aware of the direction of your question.

The CHAIRMAN. I think the important thing is the Army did handle it, and it was successful, and then it was dropped.

Any further questions?

Mr. DADDARIO. Yes.

The CHAIRMAN. Mr. Daddario.

Mr. DADDARIO. Doctor, you have mentioned something about a drug that you are developing for chemical protection against total body radiation.

Where do we stand at the moment in this program?

Colonel TAYLOR. We have another witness here, Colonel Hartgering, who is prepared to discuss this if you desire.

The CHAIRMAN. Would it be all right with you, Mr. Daddario, to wait on him? He is the next witness.

Mr. DADDARIO. Yes, sir.

Do you have any thoughts on the question of the capacity of the Department of Defense now to take care of the national requirements insofar as our space effort is concerned? Do you believe that we have the proper base upon which to—well, do you believe that we, first of all, have the proper requirement in the Department of Defense and do you believe that we can develop, on top of what we have, the capacity to take care of our requirements in the future?

Colonel TAYLOR. The answer, as far as I am concerned personally, to both of these questions is "Yes."

Mr. DADDARIO. And can you see any limitation on this capacity by the problems that would be involved in coordination between NASA and the Department of Defense and the passage of the NASA requirements to the Department of Defense to take care of their requirements in space?

Colonel TAYLOR. As I understand your question, is there an insurmountable problem present, following through on the rest of your previous statement?

Mr. DADDARIO. Yes.

Colonel TAYLOR. This obviously could be arranged either way.

Mr. DADDARIO. That is all, Mr. Chairman.

The CHAIRMAN. Any further questions?

Mr. Riehlman?

Mr. RIEHLMAN. I have no questions.

Mr. BASS. No questions.

The CHAIRMAN. Mr. Moeller said he had one additional question.

Mr. MOELLER. Doctor, I was wondering if you concur in what the previous witness said about the necessity for NASA's organization of this research group and institution. Do you feel that there could be this collaboration between existing Army facilities with NASA and be a fruitful arrangement for the overall purpose? Do you agree that this is the role that NASA should be playing and that the Army would contribute its share to it?

Colonel TAYLOR. As far as the Department of the Army is concerned—and I am restricting this deliberately—our current requirements in this area could easily be arranged in line with the previous statement by Dr. Clark Randt.

Mr. MOELLER. Would it mean then that you would be giving up some of what you are now doing?

Colonel TAYLOR. I hope not.

Mr. MOELLER. But it could be a case of merely a transferral from Army to NASA?

Colonel TAYLOR. Yes, sir.

I am aware of this problem.

Mr. DADDARIO. Would the gentleman yield on that particular point?

Mr. MOELLER. Yes.

Mr. DADDARIO. I am concerned about the coordinating aspects, Doctor, because it seems there is some question in the minds of the people in NASA as to what the Department of Defense's capacities are.

Dr. Dryden, before Mr. Thomas' Appropriations Subcommittee, was asked by Mr. Thomas, "What is the basis of your new program?"

Dr. Dryden said, "We are in the space business, the business of putting man in space."

Then Mr. Boland asked, "Is the Department of Defense doing precisely the same thing with respect to the sciences that you are doing?"

Dr. Dryden said, "The Department of Defense is engaged in bioengineering."

Now, you are actually not engaged in bioengineering——

Colonel TAYLOR. No.

Mr. DADDARIO (continuing). As I have understood your testimony.

Colonel TAYLOR. As far as the Army Medical Service is concerned, our program has been established primarily in basic research and problems related to the anticipated military problems that the Army faces.

As byproducts of these programs, applied information may well apply to the Nation's space effort. There is no directed program which highlights bioastronautics in the Army Medical Service.

Mr. DADDARIO. But you have developed a capacity in this field as a result of your other endeavors?

Colonel TAYLOR. Yes, sir.

The CHAIRMAN. Now, we have one more witness this morning, Lt. Col. James B. Hartgering, and he, likewise, has considerable background—in fact, extensive background—along the lines of medicine, and in this particular field.

I understand the colonel doesn't have a prepared statement but will answer questions.

Colonel, I suggest this, that if you will both, Colonel Taylor, you and Colonel Hartgering, have a seat there together, we can ask Colonel Hartgering questions and still have you available, too, to answer them.

Colonel TAYLOR. Yes, sir.

The CHAIRMAN. In that way we can proceed more expeditiously.

Now, I suggest this—We have a good attendance here of the subcommittee—that we try to finish just a few moments early and then go into executive session. I have a matter in reference to these hearings that I would like to bring up and discuss with the members who are present.

Now, Colonel, you have had long experience, haven't you, in this field of life sciences?

STATEMENT OF LT. COL. JAMES B. HARTGERING, CHIEF, MEDICAL AND BIOLOGICAL SCIENCES BRANCH, LIFE SCIENCES DIVISION, OFFICE OF CHIEF OF RESEARCH AND DEVELOPMENT, DEPARTMENT OF THE ARMY [1]

Colonel HARTGERING. Yes, sir.

The CHAIRMAN. You are with the Department of the Army?

Colonel HARTGERING. I am with the Department of the Army, the Army Research Office, here in Washington.

The CHAIRMAN. Where are you located?

Colonel HARTGERING. At Arlington Hall, sir.

The CHAIRMAN. In Virginia?

Colonel HARTGERING. In Virginia, sir.

The CHAIRMAN. Colonel, could you give us briefly some idea of your present work in reference to space medicine?

Colonel HARTGERING. I am a medical officer assigned to General Trudeau's staff, with the responsibility of coordinating the overall biological and medical programs within the Department of the Army.

Obviously, the biggest factor is the Surgeon General's program, which Colonel Taylor has spoken of previously.

We also have biological experiments by our other technical services, including the Quartermaster Corps, Chemical Corps, and some work by the Engineers as relating to their specific Army missions.

The CHAIRMAN. Do you have occasion to work with NASA and other agencies of Government in the course of your work?

Colonel HARTGERING. I have been recently appointed to the DOD-NASA Coordinating Group which meets at the call of the chairman to discuss general problems of interest to both agencies.

The CHAIRMAN. That DOD–NASA Coordinating Group would coordinate many of these programs that we have here, would it?

Colonel HARTGERING. Yes, sir.

The CHAIRMAN. That is the purpose, isn't it?

Colonel HARTGERING. Yes, sir.

The CHAIRMAN. I am not going into the question of radiation; my colleague, Mr. Daddario, wants to ask you some questions on that matter and I will yield to him at this point. I recognize him at this point.

Mr. DADDARIO. Thank you, Mr. Chairman.

Could you explain to us, Colonel, just where we are at this time in the development of the antiradiation drug?

Colonel HARTGERING. Historically, as you know, about 1950, the observation was made by a number of scientists around the world that it was possible to protect animals against lethal whole body radiation by administering drugs ahead of time. This was only possible in

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[1] Biography of Lt. Col. James B. Hartgering, Medical Corps, U.S. Army: Born Detroit, Mich., Oct. 30, 1919. Bachelor of arts degree, Cornell, 1940; doctor of medicine degree, 1943; master of public health degree, Johns Hopkins, 1954. Chief of obstetrics and gynecology, Tripler Army Hospital, Hawaii, 1946–47; surgeon, Sandia Base, Armed Forces special weapons project, 1947–50; radiological safety officer, Operation Upshot-Knothole, Nevada Proving Grounds, 1952; medical radiological safety adviser, Operation Tumbler-Snapper, 1952; medical consultant to III Corps, Operation Desert Rock I, 1951; Chief, Medical Branch, Armed Forces special weapons project, Washington, D.C., 1950–53; Chief, Department of Biophysics, Walter Reed Army Institute of Research, WRAMC, 1954–55; Director, Division of Nuclear Medicine, Walter Reed Army Institute of Research, WRAMC, 1955 to May 1959. At present, Chief, Medical and Biological Sciences Branch, Life Sciences Division, Army Research Office.

rodents until about 2 years ago, when Walter Reed scientists demonstrated that the dog and the monkey could also be protected against what were otherwise lethal amounts of radiation by giving drugs beforehand.

The problem is that the drugs, in themselves, are toxic to man. We have an extensive program funded through the Department of Defense to synthesize new compounds which will have the protective action, already demonstrated, but will not have the toxic effects. As you know, this is an old problem in medicine. One finds a new compound that will cure disease, but sometimes it has side effects that are undesirable, and research is then directed to eliminating these side effects by changing the chemical structure of the particular compound.

Mr. DADDARIO. Could you estimate when you will be able to overcome these problems and when this drug might be usable?

Colonel HARTGERING. There are various possible uses of such a compound. General Trudeau, in testimony to Congress this year, estimated that within 2 years we should have something that would be available if we were willing to accept a limited amount of toxicity. For example, in a fallout situation, where you knew it was coming and you couldn't do anything about it, you might be willing to accept some vomiting, nausea—this sort of toxicity. However, for space flight purposes we can't accept any toxicity, and this may require a somewhat longer period of time.

Mr. DADDARIO. There is an objective, then, to develop this for the mass population?

Colonel HARTGERING. Yes, sir. This is a side objective. Obviously it will work for the mass population as well as for the military in a combat area.

Mr. DADDARIO. If you take it before——

Colonel HARTGERING. Before radiation.

Mr. DADDARIO. Before fallout or afterward?

Colonel HARTGERING. Before.

Mr. DADDARIO. What would be the lasting effect of it?

Colonel HARTGERING. You mean how long is it effective?

Mr. DADDARIO. Yes.

Colonel HARTGERING. The current compounds we are working with on animals are effective for about 4 hours. You can give them orally to the animals 4 hours before radiation and they are effective.

Mr. DADDARIO. Under the present circumstances you can look forward to this as being part of the overall civil defense? This drug would be available to families who, on proper warning, would take it at a certain specific time. Is that about the size of it?

Colonel HARTGERING. That is our hope, sir.

Mr. DADDARIO. Doctor, in following the line of other questions in respect to the Department of Defense capacity in the field of aerospace medical research, do you believe, from your knowledge of this subject, that the Department of Defense has the present capacity to take care of our national requirements in space, and if it has the capacity to develop the necessary requirements to take care of our future needs?

Colonel HARTGERING. I can only answer this in the affirmative. The major part of the Nation's medical manpower knowledgeable in the space field is within the U.S. Air Force in the Department of Defense.

Mr. DADDARIO. And do you see that there could be any difficulty in establishing the channels through which NASA could pass its requirements to the Department of Defense so that these capacities could be properly utilized?

Colonel HARTGERING. No, sir, I do not.

Mr. DADDARIO. That is all, Mr. Chairman.

The CHAIRMAN. I would like to ask you the same question about FAA. Are you capable of handling the same problems that FAA would handle in its program of space medicine?

Colonel HARTGERING. Sir, I don't happen to be familiar with FAA, and I am not sure what their responsibilities are. Therefore I would rather not comment.

The CHAIRMAN. Mr. Moeller?

Mr. MOELLER. Doctor, may I ask: Do you believe that there is today sufficient integration and coordination in the branches of the services now in the field of medical space research?

Colonel HARTGERING. Certainly within the Department of Defense, I think medical coordination is excellent.

Mr. MOELLER. You are satisfied with it in the Department of Defense?

Colonel HARTGERING. Within the Department of Defense.

Mr. MOELLER. Properly understood, the encroachment of NASA into this field, what effect do you feel this might have on the workings of the various branches at the present time? Would there be a lessening? Would they intensify their interest? Would there be, as it has been alluded to here many times, a lot of duplication in this field?

Colonel HARTGERING. Coordination among medical scientists is probably as good as in any other science in the country, and I think that the answer, whether this can be done one way or the other, depends on the desires of the country and Congress. How big a program do we want in space medicine? We have certain capabilities within the Department of Defense now. If we want these capabilities augmented, there are two ways to do it. Either you can set up another agency or you can augment the existing capabilities which are available and have been underway for a good many years.

Mr. MOELLER. I think you can see our concern, Doctor. It is that this program be an ongoing program; in other words, we realize that it is going to increase in magnitude. Certainly we would hate to see at this juncture something take place that would make the program less efficient.

Colonel HARTGERING. Yes, sir.

The CHAIRMAN. We are interested in saving every dollar we can, of course, of the taxpayers' money.

Mr. MOELLER. This may sound a bit facetious, but as I saw the information on the witness here, you were at one time chief of obstetrics and gynecology. How did you get into radiation? [Laughter.]

There seems to be little relationship, or maybe there is a greater relationship than I am aware of.

Colonel HARTGERING. No, sir. The Army assigned me as commanding officer of the hospital at Sandia Base on my return from overseas after World War II. As commander of the Sandia Base Hospital in Albuquerque, I had radiation problems and responsibilities,

and I became extremely interested in the field. I stayed with the radiation sciences and the research field.

The CHAIRMAN. I will have to compliment you, Colonel, as being versatile, also. [Laughter.]

May I ask you this question: Coming back to the question that Mr. Daddario brought up there with reference to the development of protection against radiation, that is a byproduct of the research you are doing now in space, is it?

Colonel HARTGERING. No, sir. As Colonel Taylor indicated, the Army does not now have a space program identified as such.

The CHAIRMAN. But you have had?

Colonel HARTGERING. We did have a space program in connection with the Able and Baker experiment. But this really was exploiting an opportunity. Medical officers were available at Huntsville, and an opportunity on a space-available basis presented itself. We used the opportunity as any scientist would, to get the job done.

The CHAIRMAN. You know, of course, they have the Van Allen belt up there, and you have to pass through there sometime with living creatures and you are now looking forward to an antidote to protect against radiation. Of course the development of this for space purposes would make it available to the people throughout the length and breadth of the country; that is correct, isn't it?

Colonel HARTGERING. That is right.

The CHAIRMAN. If it is pursued for use in space, why, then, that would be a byproduct of the space effort. As it is now, you are probably pursuing it for civil defense.

Colonel HARTGERING. We are pursuing it now because the combat soldier, fighting on a nuclear battlefield, will need protection. This is why we initiated the work. When it looked as if we could find some answers, we explored it. This is well coordinated with the Atomic Energy Commission.

The CHAIRMAN. Is that a pill, or is that an injection?

Colonel HARTGERING. The compound we are now working with is pills for oral ingestion.

The CHAIRMAN. You would take a pill, for instance, when word comes from Intelligence that rockets or missiles have taken off from foreign shores in anger against us and word would go out to the population that they ought to take a pill; is that about it?

Colonel HARTGERING. Yes, sir; that summarizes it pretty well.

The CHAIRMAN. Then while they would be inconvenienced with nausea and all of that, they would be pretty well protected against the radiation effects of intercontinental ballistic missiles?

Colonel HARTGERING. Up to a certain point. These compounds work on a dose reduction basis. We are currently working at the lethal dose level, the amount of radiation that will kill 100 percent of the population. They do not become sick at all. If we double the doses to which we expose the animals, to say twice the amount that will kill 100 persent of the population, about half of them will be sick from the radiation. So it is a dose reducing compound, rather than a complete cure-all. You can deliver such a high dose that the compound will not be effective.

The CHAIRMAN. But minimum dosage of radiation and perhaps medium amounts of radiation, you think, can be forestalled by the use of this medicine?

Colonel HARTGERING. Yes, sir. We have dogs that are now 2 years postexposure to doses that killed all of the control animals in a week. They are alive, and perfectly healthy 2 years later.

The CHAIRMAN. That, in itself, is a very good result, isn't it?

Colonel HARTGERING. Yes, sir; we feel that if you can protect a dog, you can protect man if you are just wise enough to figure out how to reduce toxicity.

The CHAIRMAN. Of course, you have to convince mankind to take that pill. That is one thing that is going to be a problem.

Psychologically, you will probably be able to do it.

Mr. DADDARIO. Would you yield?

The CHAIRMAN. I would like to, if I may, ask one more.

In reference to weightlessness, how are you tackling that problem in your program now, and how can you——

Colonel HARTGERING. The Army has no studies in weightlessness, sir.

The CHAIRMAN. In the psychological problem of being aloft and orbiting the Earth, how are you attacking that problem?

Colonel HARTGERING. We have no research in this area. However, we have related work because there are military problems on the ground where personnel will be in isolated situations for long periods of time.

The CHAIRMAN. What I am trying to get at is this: Are there problems in the space program which would not necessarily interest you, for instance, or the Army at this time and, if so, who will push those problems?

Colonel HARTGERING. No. All problems of space medicine are of direct interest to the Army. Someday it may be required to have Army personnel go into space to fight, and we are vitally interested in all space research. Right now, with the capabilities that we have, we do not have an active program in this area. Others are doing it, and we keep in close contact with their work.

The CHAIRMAN. Is the Army pursuing also the problems of sustaining life on another celestial body, like the Moon, for instance?

Colonel HARTGERING. No, sir; we have no direct work in that. But as others have said, the related fundamental medical research has to be the source of the eventual answer to life on other planets.

The CHAIRMAN. I think, too, the rules of medicine run through the whole needs of humanity?

Colonel HARTGERING. Yes, sir.

The CHAIRMAN. It is the effect of chemicals—treatment on human beings there, and the rules ought to be the same.

Mr. Moeller.

Mr. MOELLER. Doctor, I was wondering a moment ago when you were discussing the development of this antiradiation medication, is this being actively pursued now by others aside from the Army, our large pharmaceutical houses, biological laboratories in the business now; are they also independently in search of something, or is this totally in the hands of the military at the present time?

Colonel HARTGERING. To the best of my knowledge, the pharmaceutical houses do not have a program in this area. Some are doing contract work for us.

Mr. MOELLER. All right.

Now, is there some coordination between them and you? Do they know you are in search for this?

Colonel HARTGERING. Yes, sir. We have talked to all of the leading concerns to enlist their help.

Mr. MOELLER. In other words, it wouldn't be a case of the Government going out on one tangent in a development program of this sort and private industry doing the same thing?

Colonel HARTGERING. To the best of my knowledge, this is not going on.

Mr. MOELLER. Well, who would know?

Colonel HARTGERING. I should. I have talked personally to the leading researchers in our pharmaceutical houses, and they do not have a program in this area.

Mr. MOELLER. And if they do engage in something of this nature they would naturally consult you?

Colonel HARTGERING. We would certainly hope so.

The CHAIRMAN. Is that an expensive medicine?

Colonel HARTGERING. The compounds that we are now working with are very inexpensive.

The CHAIRMAN. So it would be fully available to anybody in the United States if it is thoroughly tested out; you are satisfied the aftereffects would not be too detrimental?

Colonel HARTGERING. That is right, sir.

I would like to emphasize that we do not now have a compound. We are working toward one.

The CHAIRMAN. You have a compound that has kept primates alive for 2 years when they should have been dead, haven't you?

Colonel HARTGERING. Dogs, not primates. We have not followed any of the primates.

The CHAIRMAN. Dogs alive 2 years, and these dogs should have been dead by any other normal test?

Colonel HARTGERING. That is right. But that particular compound is too toxic for human use.

Mr. MOELLER. This is extremely important to me, Doctor. Now, why aren't you inviting pharmaceutical houses to get into this business?

Colonel HARTGERING. We have, sir, invited every single pharmaceutical house in America to participate in the program. I have personally talked to about two-thirds of them, and the people at Walter Reed have talked to the rest of them. I happened to be assigned at Walter Reed when this program was initiated.

Mr. MOELLER. This would be an area where we could certainly do something for our civilian population while, of course, we want everything done for the military, the combatants. Certainly this would be a means of preservation of human life, and if there could be such a thing as a crash program here I think it ought to be engaged in.

The CHAIRMAN. I think this, that we would like to have the colonels, either one of them, and Dr. Randt, too, who has already testified, to point out to this committee wherein we can be of assistance in this type of program, because I think it is that important.

Colonel HARTGERING. We are currently funded at a level of about a million dollars a year through the Department of Defense. With

this fund we have something of the order of 85 to 90 percent of the Nation's total sulfur chemists already on contract to us.

I think it is about the maximum effort that we can now support. Sulfur chemistry is extremely difficult chemistry. There is a relatively small group of people with competence in this area, and they are already under contract.

I think that at the present time the program is reasonable.

The CHAIRMAN. So there is no legislative authority you need at this time?

Colonel HARTGERING. No, sir. At this time I do not see any. You have already given us the authority in the appropriations to handle this program.

Mr. DADDARIO. Will you yield?

The CHAIRMAN. Yes, Mr. Daddario.

Mr. DADDARIO. These dogs that you have kept alive for 2 years in these drug experiments, have any of them had any pups, and what has been the effect?

Colonel HARTGERING. No, sir; they have not had any pups. We just haven't studied that phase of the problem.

Mr. DADDARIO. You haven't gone into that experiment?

Colonel HARTGERING. In the rodent population it is known that the offspring of rodents are completely normal. These compounds protect against all of those effects. An across-the-board dose reduction effect is produced, including genetic changes. We haven't done this in dogs because we didn't have the space to do it, and there didn't seem to be any pressing reason. We are reasonably sure that the offspring will be perfectly normal.

Mr. RIEHLMAN. I have two questions.

The CHAIRMAN. Mr. Riehlman.

Mr. RIEHLMAN. You stated that you did have a contract with one of the pharmaceutical companies in this research program. What company do you have that with, do you know?

Colonel HARTGERING. We have approximately 35 contracts in this program. I have been away for more than a year from the direct contracting aspects of the program, and I cannot answer your question.

Mr. RIEHLMAN. It is not so important, the company, but isn't there a possibility that there would be other pharmaceutical companies that would be interested in this research program with the Department of Defense?

Colonel HARTGERING. We have contacted them, and the ones that have been interested are being supported.

Mr. RIEHLMAN. One other question. You are on the coordinating board between the Department of Defense and NASA?

Colonel HARTGERING. Yes, sir; I am one of the Army members.

Mr. RIEHLMAN. How often does this board meet, Doctor?

Colonel HARTGERING. I was just appointed. I couldn't answer that question. Colonel Taylor informs me that it met in April, and is scheduled to meet again the 22d of June.

Mr. RIEHLMAN. Who is chairman of the board?

Colonel HARTGERING. Dr. Orr Reynolds, Director of Science in the Department of Defense.

Mr. RIEHLMAN. Department of Defense?

Colonel HARTGERING. Yes.

Mr. RIEHLMAN. Of course, you haven't served long enough to get any good observation as to the effectiveness of the coordination between the Department of Defense and NASA.

Colonel HARTGERING. Colonel Taylor can answer this. He has been a member of the board.

Colonel TAYLOR. I think I can answer this. This relationship has just been developed, and the first meeting was held a month or so ago. The second meeting is coming up. So far, this interphase has now been described but the coordination has not been effected as yet.

The CHAIRMAN. I want to commend the Department of the Army and DOD for getting together and working out a coordinating arrangement. I think it is highly necessary.

May I ask one final question, Colonel: Did you doctors learn anything of any value from the experiences over there in Japan, and were the Japanese helpful to us in any way, especially the Japanese doctors, were they helpful in giving their experiences to us?

Colonel HARTGERING. Yes, sir; we learned a great deal and the Atomic Energy Commission, as you know—I believe it is administered through the National Academy of Sciences here in Washington—has a long-range continuing program which is known as the Atomic Bomb Casualty Commission. We are obtaining a great deal of very useful information from these long-term studies.

The CHAIRMAN. I am glad to hear that.

Now if there are no further questions, I think we ought to meet in executive session 3 or 4 minutes here. We want to thank Colonel Taylor and Colonel Hartgering and Dr. Randt, all of you, for coming here this morning and assisting us in this hearing.

The committee will now go into executive session.

(Whereupon, at 11:58 a.m., the committee went into executive session to discuss administrative matters, following which it adjourned at 12:05 p.m., to reconvene at 10 a.m., Thursday, June 16, 1960.)

SPACE MEDICINE RESEARCH

THURSDAY, JUNE 16, 1960

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SPECIAL INVESTIGATING SUBCOMMITTEE,
Washington, D.C.

The subcommittee met at 10 a.m., Hon. Overton Brooks (chairman) presiding.

The CHAIRMAN. The committee will come to order.

This is the second of 2 days of hearings on the problems of the national effect in the field of space medicine research. Yesterday we heard from representatives of the National Aeronautics and Space Administration and the Department of the Army. Today we are going to hear from the Departments of the Navy and the Air Force, as previously announced. As I understand it, the Navy wishes to be heard first, and Capt. Clifford P. Phoebus, director of the Astronautical Division of the Bureau of Medicine and Surgery, Department of the Navy, is our witness. He is playing a very important role at this time in the Navy's effort in this field.

We have a great deal of information regarding the captain's background. In 1951 through 1953 he headed the Aviation Medicine Branch of the Research Division of the Bureau of Medicine and Surgery. He was in research administration in the field of aviation medicine, deputy member of the Medical Sciences Committee, RDB, member of the Human Engineering Panel of the Human Resources Committee, RDB, member of the Armed Forces-National Research Council Vision Committee, had additional duty with the Air Branch, Office of Naval Research; and had a certificate issued for completion of special weapons orientation course at Sandia Base, N. Mex.

The captain also served from 1953 to 1958 as Special Assistant for Medical and Allied Sciences, Office of Naval Research, and had general cognizance over the ONR programs in biological, psychological, and medical sciences. This job was primarily one of liaison with all groups and agencies having an interest in this field.

Now, for the members of the committee, we have his record here, and it is extensive, and it is complicated, and it is very active.

So, Captain, we will be very happy to have you, if you would sit here forward, sir. And you have a prepared statement, I believe?

Captain PHOEBUS. Yes, sir.

The CHAIRMAN. If you will proceed with your prepared statement, sir, we will appreciate it.

Captain PHOEBUS. Yes, sir.

STATEMENT OF CAPT. CLIFFORD P. PHOEBUS, DIRECTOR, ASTRONAUTICAL DIVISION, BUREAU OF MEDICINE AND SURGERY, DEPARTMENT OF THE NAVY [1]

Mr. Chairman and members of the committee, it is my pleasure to present to you certain facts concerning the naval medical research pro-

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[1] Biography of Capt. Clifford Preston Phoebus, Medical Corps, U.S. Navy:
Address: 210 Hazelton St., Falls Church, Va.
Date of birth: May 11, 1910 (Baltimore, Md.).
Marital status: Married Mar. 12, 1938, at Elkton, Md. Wife: Bernadine Shultz (Phoebus), former nurse. Sons: Charles Richard, born Jan. 31, 1940, Honolulu, Naval Academy, 1962. James Clayton, born May 15, 1942, Quantico, Va. Clifford Preston, born Jan. 31, 1945, Pensacola, Fla.
Education: James Madison High School, Brooklyn, N.Y., 1924–28 (graduated with cum laude honors); Lafayette College, 1928–32, B.S. (chemistry and biology), premed student; Jefferson Medical College, 1932–36, M.D.; George F. Geisinger Memorial Hospital, 1936–37, internship.
Organization memberships: Delta Tau Delta; Alpha Chi Sigma; Alpha Kappa Kappa; member, American Medical Association; member, Aerospace Medical Association since 1952; in 1953, Navy representative on scientific program committee for 1954 meeting of Aerospace Medical Association; on June 11, 1954, appointed chairman, scientific program committee for 26th annual meeting (1955); member, space medicine branch of Aerospace Medical Association since 1954; in May 1957, elected chairman, membership committee. Elected chairman, space medicine branch, 1959–60; member, Association of Military Surgeons; board certified by aviation medicine section of the American Board of Preventive Medicine on Nov. 8, 1953 (as one of the founders' group); selector, International Academy of Aviation Medicine, 1958; member, section on military medicine, Pan American Medical Association, October 1959.
Honors: Elected fellow of Aerospace Medical Association and appointed member of the executive council for a 3-year period at the annual meeting held May 1957 in Denver, Colo.; received Lyster Award for outstanding achievement in aviation medicine, at the annual meeting of the Aerospace Medicine Association held April 1959 in Los Angeles, Calif.

Military training and duties

Aug. 19, 1937: Appointed lieutenant, junior grade, Medical Corps, U.S. Navy.
August 1937 to April 1938: Student at Naval Medical School, completed basic course, including field medical school course at Marine Corps School, Quantico, Va. Certificate granted.
May and June 1938: Attended U.S. Army Chemical Warfare School, Edgewood Arsenal, Md. Certificate granted.
July to November 1938: Attended U.S. Army Air Force School of Aviation Medicine, Randolph Field, Tex. Designated U.S. naval flight examiner, Nov. 12, 1938.
November 1938 to May 1939: Student flight surgeon at Naval Air Station, Pensacola. Designated U.S. naval flight surgeon.
June 1939 to April 1941: Duty on U.S.S. *Enterprise* (CV–6) as air group flight surgeon and junior medical officer.
April 1941 to December 1942: Assistant medical officer at U.S. Marine Corps Air Station, Quantico, Va. Installed first small Navy low-pressure chamber.
August 1941: Promoted to lieutenant.
December 1942 to April 1944: Wing flight surgeon of Fleet Air Wing 15 at Port Lyautey, French Morocco.
March 1943: Promoted to lieutenant commander.
April 1944 to October 1944: Assistant staff medical officer on the staff of commander, Air Force Atlantic Fleet, Norfolk, Va.
October 1944 to September 1945: Student naval aviator at Naval Air Stations, Ottumwa, Iowa, and Pensacola, Fla. Designated naval aviator on September 18, 1945.
July 1945: Promoted to commander.
October 1945 to February 1947: Senior medical officer on U.S.S. *Shangri-La* (CV–38). Ship's employment included Operation Crossroads at Bikini.
March 1947 to July 1947: Senior medical officer at Naval Air Auxiliary Station, Cecil Field, Jacksonville, Fla. Instruction and training of students in physiological problems of flight.
July 1947 to August 1950: Medical executive officer at dispensary, Naval Air Station, Norfolk, Va., including duty as naval aviator in air evacuation mission. Certificate granted on completion of course in medical aspects of radioactivity at Naval Medical School, Bethesda, Md., on Feb. 28, 1948.
August 1950 to October 1951: Duty on U.S.S. *Coral Sea* (CVB–43) as senior medical officer. Ship's employment acted as hospital ship for 6th Fleet in Mediterranean waters. Organized safety board which delved into all phases of shipboard safety.
November 1951 to May 1953: Head, Aviation Medicine Branch, Research Division, Bureau of Medicine and Surgery. Research administration in the field of aviation medicine. Deputy member, Medical Sciences Committee, RDB. Member, human engineering panel of Human Resources Committee, RDB. Member, Armed Forces-NRC Vision Committee. Additional duty with Air Branch, Office of Naval Research. Certificate issued for completion of special weapons orientation course at Sandia Base, N. Mex., in November 1952.
June 1953: Promoted to captain.
June 1953 to July 1958: Special Assistant for Medical and Allied Sciences, Office of Naval Research. General cognizance over the ONR programs in biological, psychological, and medical sciences. This job was primarily one of liaison with all groups and agencies

gram, and specifically the Navy's program in space medicine. In doing so, I should like to emphasize the fact that although the Navy has certain unique interests and capabilities in space medicine, we are fully aware of the fact that our program requires coordination with the programs of other governmental agencies.

In fact, I can report that upon assuming my present position as Director of the Astronautical Division of the Bureau of Medicine and

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having interests in this field and in the coordination of these interests with the ONR research program. Much of this work was carried on by means of membership in various committees.

Member of Office of Naval Research staff activities: Planning council, program council, senior scientific council, admiral's staff conference.

Member of BuMed staff activities: Flight surgeons' council, research division council.

July 5, 1953 to July 24, 1958: ONR member, Armed Forces-NRC Committee on Vision. Apointed Navy member on executive council January 1955.

July 6, 1953 to July 24, 1958: Appointed ONR member of NRC Division of Medical Sciences.

December 18, 1953 to 1957: Deputy member on R. & D. Coordinating Committee on Medical Sciences, OASD (R. & E.).

September 28, 1953 to 1956: Appointed by BuMed as subject matter consultant on Navy training films and technical adviser to NPC and film producer. The films include: (1) "Naval Medical Research, a Survey," pt. I, MN–7929A; (2) "Naval Medical Research, a Survey," pt. II, MN–7929B; (3) "Medical Aspects of High Intensity Noise—General Effects," MN–9318a; (4) "Medical Aspects of High Intensity Noise—Prevention of Hearing Losses," MN–9318b; (5) "Medical Aspects of High Intensity Noise—Ear Defense," MN–9318c.

January 7, 1954, to July 24, 1958: Member of Department of the Navy Committee on Pest Control.

July 1, 1953, to July 1, 1957: U.S. Navy member, aeromedical panel, Advisory Group for Aeronautical Research and Development (AGARD), NATO.

August 13, 1954, to July 24, 1958: Designated chairman of ONR advisory committee for aircraft instrumentation program.

October 5, 1954, to June 30, 1955: Member, panel on underwater swimmers of NRC Committee on Undersea Warfare.

October 18, 1954, to July 24, 1958: Designated as Navy member of executive council of Armed Forces-NRC Committee on Hearing and Bioacoustics. Chairman of executive council, October 24, 1955, to October 1957.

January 27, 1955, to July 24, 1958: Member, Naval Advisory Committee on Human Engineering. Chairman, March 2, 1955, to March 1956.

May 4 to October 18, 1955: ONR representative on Ad Hoc Committee on Jet Aircraft Operations, U.S. Navy.

October 13, 1955, to April 30, 1957: Member, ONR Advisory Committee for the Control Systems Laboratory.

January 1, 1956, to July 24, 1958: Member, NACA Subcommittee on Aircraft Noise.

February 1, 1957, to July 24, 1958: Member, Armed Forces Pest Control Board. Member, AFPCB Committee on Pests That Destroy Property and Material.

April 1954 to July 24, 1958: Member, Personnel Antifragmentation Coordinating Committee. Certificate issued on completion of guided missiles course at Navy Special Weapons School in Norfolk, Va., in June 1954.

Spring 1958: Developed the concept of and participated in various conferences which led to the formation of the Armed Forces-National Research Council Committee on Bioastronautics. Member, steering committee for "Symposium on Possible Uses of Earth Satellites for Life Sciences Experiments," held at Willard Hotel, Washington, D.C., May 14–17, 1958. Sponsors: AIBS, NAS, NSF.

August 14, 1958, to June 10, 1959: Student, U.S. Naval War College, Newport, R.I. (course in naval warfare). Term papers: "Biological Warfare and Its Relation to National Strategy" (classified); "The Navy Looks at Space."

March 23, 1959: Qualified as a Navy standard instrument pilot.

July 2, 1959, to present: Director, Astronautics Division, Bureau of Medicine and Surgery, Navy Department. This position involves coordination of the Navy's internal program in bioastronautics and coordination of that program with all other agencies. Member, Armed Forces-National Research Council Committee on Bioastronautics (alternate Navy member, executive council) and member panel on identification of long-range problems. Member, National Aeronautics and Space Administration Life Sciences Committee. Member, DOD Technical Advisory Group for Bioastronautics. Member, Clinical Evaluation and Development Board, NNMC. Appointed chairman, Scientific Program Committee, Association of Military Surgeons in December 1959. Presented paper, entitled "Man in Space," to International College of Surgeons, Chicago, Ill., Sept. 17, 1959. Attended course on "Medical Aspects of Missiles and Space Operations" at Cape Canaveral, Fla., Jan. 10–15, 1960.

Publications and published participation in scientific meetings

1. Phoebus, C. P., "VD Prophylaxis on a Large Carrier," special report to the Bureau of Medicine and Surgery, Sept. 27, 1951.
2. Phoebus, C. P., "The High Intensity Noise Problem," U.S. Navy Medical News Letter, vol. 21, No. 4, Feb. 20, 1953.
3. Phoebus, C. P., "The High Intensity Noise Problem in the U.S. Navy," ONR Research Reviews, February 1954.
4. Phoebus, C. P., captain, MC, USN, moderator, "Problems of Escape From High Performance Aircraft: A Symposium," with J. R. Poppen, M.D.; H. F. Mohrlock, Jr.; Capt.

Surgery, the Surgeon General of the Navy, Admiral Hogan, charged me with the responsibility for coordinating the Navy's internal program in space medicine and, further, with the responsibility for coordinating that program with the programs of all other agencies.

I can assure you that the Navy will cooperate to its utmost with this committee and will be most happy to have members of the committee and its staff visit the naval laboratories which are currently carrying on programs directly or indirectly relevant to space medicine.

The Navy carries on a broad medical research program and has developed a group of laboratories with special and sometimes unique equipment to meet special requirements, and these laboratories have been staffed by a group of scientists with unusual competences in a variety of fields.

This research and development program is, of necessity, broad in scope because of the diversity of the Navy's operating environments. The medical research program is designed to provide immediate answers when necessary and to develop new knowledge and concepts to anticipate and provide a basis for the solution of future problems. Of necessity, we have concentrated on basic research to keep our program broad in scope and wide in application. This has resulted in such a flexibility and capability within our laboratories that when new problems arise we are in the fortunate position of being able to call upon competent scientists within our own organization to provide the research effort necessary to solve these new problems. Space medicine is an outstanding example. Only certain of our laboratories have competence relevant to space medicine, but these are outstanding.

There are 6 Navy laboratories which are currently active in various facets of research and development in the field of space medicine. Of these 6, the Aviation Medical Acceleration Laboratory at Johnsville, Pa., the Air Crew Equipment Laboratory at Philadelphia, Pa., and the School of Aviation Medicine, Pensacola, Fla., are devoting a major portion of their current activities to space medicine: the Naval Medical Research Laboratory at New London, Conn., and the Naval Medical Research Institute, Bethesda, Md., have space medical capabilities of a significant degree, although their primary missions are in other fields; and the Pacific Missile Range, Point Mugu, Calif., is having capabilities in space medicine rapidly built up.

C. E. Wilbur, MC, USN; Col. H. G. Moseley, USAF (MC); R. H. Frost, B.S.; Lt. Col. J. P. Stapp, USAF (MC); Capt. R. A. Bosee, MSC, USN; A. F. Zeller, Ph. D.; and Comdr. G. W. Hoover, USN. Journal of Aviation Medicine, vol. 28, pp. 57–100, February 1957. (Organized symposium and served as chairman.)

5. Salazar, Alfredo and C. P. Phoebus, "Aeronautical Preventive Medicine in the U.S. Navy," paper presented to Aeromedical Panel of AGARD, NATO at November 1957 meeting.

6. Phoebus, C. P., captain, MC, USN.; "Government Sponsorship of Medical Research: A Symposium, II," bulletin of the Medical Library Association, vol. 43, No. 1, January 1955. (Presented at the 53d annual meeting, Medical Library Association, Washington, D.C., June 17, 1954.)

7. Doolittle, James H.; R. H. Bolt; Vice Adm. C. E. Rosendahl; W. Littlewood; T. L. K. Smull; D. D. Streid; H. O. Parrack; Capt. C. P. Phoebus, and H. C. Hardy, "What Are We Doing About the Noise Problem?" A forum, Air Force magazine, March 1956. (Presented at the Air Force Association's Jet Age Conference held in Washington, D.C. on Feb. 3–4, 1956.)

8. Phoebus, C. P., speaker at ONR symposium "Conference of Photosynthetic Gas Exchangers," Washington, D.C., June 11–12, 1956; published as ONR Symposium Report ACR–13.

9. Phoebus, C. P., speaker at Bell-Douglas conference on long-range instrumentation program, published as "Progress Report Conference," Sept. 19, 1956 (classified).

10. Phoebus, C. P., "Accommodating the Space Man," ONR Research Reviews, June 1958.

The Aviation Medical Acceleration Laboratory has its activities centered around the operation of the world's largest human centrifuge. This human centrifuge has capabilities far greater than any similar device known to exist. In addition to the work done to establish the parameters of human susceptibility to acceleration stress, another major asset lies in the combination of the centrifuge with the large computer at the aircraft computer laboratory, also at Johnsville. This results in a capability for dynamic flight simulation, which means that occupants of the gondola can fly exact replicas of flight patterns for both aircraft and space vehicles.

This capability has resulted in the detection of over 50 potentially fatal situations involving the X–15 aircraft, has given the Mercury astronauts the most realistic training for the Mercury flight profile which they have yet received, and provides a tool for the Armed Forces, NASA and industry for exploring the acceleration, control and display factors involved in flights of aircraft and space vehicles.

There are many ancillary studies being conducted at the Aviation Medical Acceleration Laboratory in the fields of instrumentation, equipment design, biopack development, performance under stress, biochemical stress indicators, etc. This laboratory is a national asset.

The Air Crew Equipment Laboratory has for many years been a leader in the design and development of specialized air crew equipment. Such things as immersion suits, full pressure suits, protective helmets, restraint apparatus, ejection seat equipment, oxygen masks and regulators, and crash protection equipment have been designed and developed in this laboratory. The laboratory is currently heavily involved in various supporting activities for the Mercury astronaut program. The full pressure suit which the astronauts will wear was designed and developed here. Human engineering studies of the displays and controls for the Mercury capsule are currently underway. Heat stress profiles for the Mercury flight have been tested with human subjects.

The Mercury astronauts will receive training in a full-scale mockup of a Mercury capsule placed inside of one of the largest low pressure chambers in the country located at this laboratory. A number of experiments involving exposure of crews to simulated space flight conditions over periods of many days have been carried out. Current developmental efforts seeking adequate sources of oxygen while at the same time absorbing CO_2 and water vapor have focused attention upon the potential usefulness of superoxides for this purpose.

This laboratory's principal role lies in its capability to apply the results of research to the development of usable items of hardware. Nearly all aviation personal protective equipment now used in the fleet has been developed and/or evaluated at Air Crew Equipment Laboratory. A significant role for this laboratory in the design and development of equipment for man's utilization of future spacecraft is assured.

The School of Aviation Medicine at Pensacola has long been active in many fields of aerospace medical research. It was here that the biopack was designed which resulted in the world's first flight of a primate into space and the recovery of the animal alive. This was the famous monkey, Baker ballistic trajectory flight conducted in May of 1959. And as you heard yesterday this was conducted in

conjunction with the U.S. Army. This small spider monkey is still very much alive and active in her cage at Pensacola.

One of the staff members is the world's foremost authority on the biological effects of cosmic radiation. Another has been selected as the medical officer in charge of planning and executing the medical aspects of the recovery phase of Project Mercury.

A unique feature of the laboratory is its capability for studies in disorientation. These disorientation studies are vital to manned space flight in that tolerances to spinning, tumbling, unusual attitudes and isolation must be determined. The human disorientation device and the rotating room at Pensacola are unique tools for studying these disorientation problems which are unmatched elsewhere.

If the committee would care to have elaboration about this particular group of devices I would be happy to do so during the question period.

The School of Aviation Medicine also has excellent capabilities and has carried out significant work in the effects of noise on personnel, communication problems, psychological aspects of aerospace medicine, physical standards and qualification criteria, and basic studies in respiration, cardiology and central nervous system functions.

The staff is small, the spaces in which the facilities are housed are crowded, but the past record of performance of this laboratory indicates that its capability for work in space medicine is significant.

The Naval Medical Research Laboratory at the Submarine Base, New London, Conn., has been preeminent for many years in studies of men occupying closed environments. Much of our long submerging nuclear submarines' capability can be traced to work carried out in this laboratory. It seems apparent that the Navy's experiences in the closed environment which the submarine represents have almost an exact parallel in the closed environments which will be encountered in spacecraft. Fundamental studies in respiratory physiology have brought this laboratory to a peak of eminence in this field which has resulted in many other scientists beating a pathway to its door for technical information.

Other studies in human engineering, visual problems, hearing and personnel selection have direct bearing upon space medicine. The Mercury astronauts will be trained in underwater escape techniques by personnel of this laboratory. New facilities being constructed here will reinforce the laboratory's capability for further studies of closed environments, particularly in the determination of breathing problems. They have already determined the safe level for long-term exposure to carbon dioxide. Now their attention is being directed to the ideal composition of respiratory gases. No one has yet fully determined the requirement for nitrogen in man's breathable atmosphere. Here we have an example of a laboratory's capabilities for studying problems in a field of current military importance, the submarine, which has resulted in a capability for solving problems in an entirely different medium—spacecraft.

The Naval Medical Research Institute at Bethesda, Md., has the primary mission of carrying out basic studies relevant to all facets of naval medicine. Here are located a number of unique tools, and the skills to use them, which can contribute to nearly any field of naval medical research interest. For example over a period of years the

laboratory has been very active in pioneering efforts directed to the telemetering of physiological information from aircraft to ground and airborne receivers. The techniques developed here will certainly have considerable future usefulness in connection with manned spacecraft.

The human calorimeter located at Naval Medical Research Institute is another unique laboratory instrument which is unmatched elsewhere for basic studies of human heat exchange problems. The Mercury astronauts have been studied on this device.

Fundamental studies on the effects of human tolerance to vibration have been in progress here for many years. While much has been learned, there are still many unknowns in this scientific area which must be solved if man is to withstand the extreme exposures to vibration which he will encounter in the launching and reentry phases of space flight. The chemistry department at Naval Medical Research Institute has succeeded in developing the techniques for obtaining potable water from human urine. This problem, which is pertinent to spacecraft, was quickly solved through special research techniques which had been already developed in the laboratory. All that remains is the engineering development of a system applicable to a specific space vehicle. A complete list of all of the research activities being carried out at Naval Medical Research Institute of potential significance to space medicine would be inappropriate here; however, it should be pointed out that there is now being constructed at Naval Medical Research Institute the most extensive facilities for studies of the biological effects of radiation upon man that have yet been installed any place. It is expected that these new facilities, which are financed and otherwise supported primarily by the Defense Atomic Support Agency, will have relevance to radiation effects studies which will be important to future manned spacecraft.

The U.S. Naval Missile Center at Point Mugu, Calif., has recently established a Life Sciences Department. This department is being carefully staffed in order to carry out space medical studies in the unique environment represented by the Pacific Missile Range. Here is the opportunity to marry the research and development efforts of space medical laboratories to the operating environment represented by the range.

Men and animals launched into space by the range will provide the Life Sciences Department with unique opportunities for studying space medical problems. The preparation of these subjects for flight, the telemetering of them during flight and the reduction of the data obtained postflight will be a primary function of this new department. At the same time there will be many opportunities available for carrying out significant research. Much of the research effort in the biomedical problems of manned space flight can be carried out here in conjunction with engineering studies of the vehicles themselves. Arrangements have already been made for the Life Sciences Department to utilize much of the unusual equipment already installed for engineering studies such as shake tables, environmental stress facilities, pressure chambers, etc. A closely integrated medical-engineering program is already underway in the human engineering area and much more is expected to result in the future from close working relationships between medical scientists, electronics, and communication

experts, mathematicians, and other scientific disciplines not normally working in close association with life scientists. While few special facilities for space medical work are now in existence at Point Mugu, it is expected that a major buildup of such facilities will take place here in the future.

The Director of the Astronautical Division, BuMed; the commanding officers and scientific directors of the laboratories concerned; and the cognizant personnel of other Navy bureaus have reviewed the basic areas of space medicine research and have evaluated our available facilities as to their particular or unique potentials for carrying on work in this field. The laboratories' efforts have been coordinated to provide for a program free from duplication within the naval service or with other military organizations and Government agencies.

It was apparent that naval installations could not cover all scientific areas involved in space medicine, but with carefully planned programs a major contribution could be made to space medicine and to future naval operations. Accordingly, it was decided that a program of research in space medicine would be established with the following objective:

> To carry out such research, development, test, evaluation, and such other basic support as may be required to enable the Navy to place, support, and maintain men in space weapon systems in order to meet Navy operational requirements.

It was further determined that the action required to reach this objective would necessarily involve—

(*a*) Coordination with the national space program:

(*b*) Coordination of this effort with the programs of other echelons of Department of Defense and other Federal agencies;

(*c*) Maximum assistance to NASA with our unique capabilities and facilities;

(*d*) Adaptation of data derived from the national space effort to unique naval requirements; and, finally,

(*e*) Planning for and carrying out relevant supplementary studies deemed necessary for a balanced long-range Navy program.

Space medicine requires a considerable amount of breakdown into specific scientific fields. In carrying out our planning, it is particularly noteworthy that there has been a determined effort to concentrate our talents and efforts in certain laboratories. For each of the major areas identified as important to space medicine, one of our laboratories has been designated as the lead laboratory, and it is our intention to concentrate our efforts in accordance with this lead laboratory concept. For example, the Aviation Medical Acceleration Laboratory at Johnsville will be the primary focus of the Navy's efforts in the broad field of acceleration; the School of Aviation Medicine at Pensacola will be the center of our disorientation studies; the Air Crew Equipment Laboratory in Philadelphia will be the lead laboratory for the development of the specialized life support equipments necessary for manned space flight. This does not mean that individual laboratories will not have more than one major area of interest, but it does mean that there will be no conflicts of interest between our laboratories.

I would be remiss if I did not point out the fact that in addition to the inhouse capabilities of our laboratories, the Navy have been supporting a small program in bioastronautics through the Office of Naval Research. The Office of Naval Research has over a period of years selectively contracted with universities, industrial organizations, and nonprofit institutions for certain phases of life sciences research relevant to space. This program can be expanded to cover newly identified areas relevant to space, and to the Navy's requirements as necessary.

At the present time our laboratories are submitting proposals to the Life Sciences Office of NASA for their consideration of possible support in areas of mutual interest. The Navy alone does not have the funds available to fully exploit the capabilities of these laboratories. We welcome the opportunity to place our laboratories at the disposal of NASA insofar as our mutual interests dictate. We feel that we can provide a service to NASA which is unavailable elsewhere, while at the same time carrying out programs of interest to the Navy which would be difficult to pursue adequately without NASA's support.

As far as coordination is concerned, this is effected through several mechanisms. First, the informal day-to-day contacts between our scientists and administrative personnel and their opposite numbers in NASA. Of course, there is similar informal cooperation and liaison between the Armed Forces. Secondly, for several years there has been in existence the Armed Forces-NRC Committee on Bioastronautics.

Within this organization there has been the opportunity for scientists of all interested governmental agencies and representatives from industry and universities to meet together and exchange ideas and formulate approaches to the solution of space medicine problems. And, finally, there has been established at the Department of Defense level a coordinating activity under the Director of the Office of Sciences. This group has met but once so far with the representatives of NASA. It is expected that future meetings of this coordinating group at the Department of Defense level will result in the establishment of integrated policies between the Armed Forces space medicine laboratories and the NASA Office of Life Sciences. The next meeting of this group in fact is scheduled to take place on the 22d of this month.

In carrying out this program of space medical research, the Navy plans to fully utilize the facilities already in existence within the laboratories that I have mentioned. There is no major expansion of these facilities contemplated except possibly at Point Mugu, the headquarters of the Pacific Missile Range.

Here, the opportunity for marrying the research and development effort going on in other laboratories to the operational situation represented by a national missile range seems to dictate a modest life sciences establishment. We are planning for such a facility now. In the other laboratories, although there is no major expansion contemplated, it is to be expected that certain new facilities will be required as new problems are identified and as areas of emphasis change. This expansion is regarded as being no more than the usual pattern of modernization of facilities dictated by new requirements.

The CHAIRMAN. Thank you very much, Captain Phoebus. We appreciate your statement. Certainly the statement, if it shows anything, shows cooperative desire to work with the other military departments, and also with NASA, and I am especially impressed with that fact.

I want to ask you a question or two.

I think you have set forth the locations of these laboratories. How far is Johnsville, Pa., from Pittsburgh?

Captain PHOEBUS. That is a suburb of Philadelphia. It is at the northeast edge of Philadelphia, I would say perhaps 20 or 25 miles from Broad and Market Streets.

The CHAIRMAN. Your Pensacola station is set up primarily for aviation medicine?

Captain PHOEBUS. That is true, all these places were.

The CHAIRMAN. Now, you refer to it as aerospace medicine?

Captain PHOEBUS. No, sir; we still call it the School of Aviation Medicine. We have not adopted the aerospace terminology.

Mr. FULTON. I am very pleased about that, may I add?

The CHAIRMAN. I want to say, as you read your statement, I saw some reference to aerospace.

Captain PHOEBUS. I am very apologetic about that.

The CHAIRMAN. I don't think you need be apologetic, Captain.

Captain PHOEBUS. No, sir; I am not. I was being facetious.

The CHAIRMAN. Yes. At any rate, your New London lab is an outgrowth of your submarine development?

Captain PHOEBUS. Yes, sir; it has been an establishment for quite a while, and it is primarily in the field of submarine medicine.

The CHAIRMAN. But it is adaptable to space?

Captain PHOEBUS. Yes, sir; in certain aspects. This doesn't mean they will neglect their submarine medical responsibilities. But some of their work will feed into both areas.

The CHAIRMAN. Point Mugu will be the application of what you have learned elsewhere, plus what additionally you learn at Point Mugu?

Captain PHOEBUS. Yes, sir.

The CHAIRMAN. That brings us into the Bethesda, Md., research institute. Will Bethesda have the overall control?

Captain PHOEBUS. Of the space medicine program?

The CHAIRMAN. For the Navy.

Captain PHOEBUS. No, sir; the overall control of the program is from my office. The space medicine aspects of activities at the medical research institute at Bethesda are really only a small portion of their activities. They are working in other areas of clinical medicine, submarine medicine, psychology, many other fields, because the Navy is spread out in many areas. We have our undersea forces, surface forces, air forces, and amphibious forces, and so forth. We must support all of these; space is only a piece of this.

The CHAIRMAN. Is that located on the site of the Naval Medical Center?

Captain PHOEBUS. Yes, sir.

The CHAIRMAN. You referred in your statement to the vast work the Navy had done in reference to radiation.

Yesterday, we had a couple very interesting witnesses referring to the possibilities of developing countermeasures to radiation. Has the Navy been looking into that, too?

Captain PHOEBUS. Not in the same field the Army has. Our work in the development of this new center out there really has several primary ideas in mind. For one thing, it seems to us and to the Defense Atomic Support Agency and others as though with the increasing number of atomic reactors being scattered around the country and nuclear-powered ships that inevitably sooner or later there will be an accident; and if such accident occurs, we want to be in a position to be able to completely evaluate the victims of that accident and provide them with the best possible care. This is a No. 1 objective, to be a jump ahead of the game.

In addition, the facilities being installed there would be capable of a wide range of exploratory studies in the field of nuclear effects on human living tissues. We feel that where this ties into the space medicine effort is the apparent inevitability of nuclear-reactor power packages going into future space vehicles and the possibility of nuclear-propulsion units for these vehicles, plus the problems of radiation in space as exemplified by the Van Allen belt.

The CHAIRMAN. In reference to another matter you have covered here in your statement, the problems of tolerances to spinning, tumbling, unusual attitudes, and isolations, what problems, can you tell the committee, result from these things?

Captain PHOEBUS. I would like very much to tell the committee about this.

Spinning has been proposed, or should we say rotation has been proposed, as a possible substitute for gravity in space. This sounds very well until one investigates the results of rotation, even slow rotation, on people. We have within the last year established a facility at Pensacola which has provided us with some rather unique leads in this area. This amounts to a room built on the hub of our old centrifuge down there. This hub happens to be a 22-ton flywheel; and when you start it spinning, it forms a very stable platform, much like a gyro. This room is equipped with living facilities so people can live in there for days. It is some 13 feet in diameter.

With that introduction, if I may explain some of my own experiences in riding on this, I think you will get the point. You get in this room, it is closed up so you cannot see outside. As it starts to rotate you know in which direction you are going. They rotate it at a slow speed; in my case about six revolutions per minute. Very soon after you start this, you are no longer conscious of your moving in any particular direction. You can recall it, but you are not particularly conscious of it; it is stable.

Everything is fine until one starts to move his head, and then some of the most devastating symptoms occur. I might describe them as being frightening, and I think others in the room here who have ridden on this device will agree with me.

They are frightening because of the triviality of action on your part that is required to produce such devastating symptoms as nausea, vomiting, vertigo, and general malaise.

Why does that happen? So far, we feel that it is because here is a situation in which the normally dominant visual sense that orients

us in space is removed. You are in this room, and as far as you are concerned it is not moving. Therefore, this gives opportunity for the vestibular organs in the ears' canals to take over, and the stimuli which are normally suppressed or dominated by vision then have full sway, with pretty severe results.

This offers an opportunity with this device to do several things: to evaluate the effects of slow rotation on men, to grade men according to their susceptibility to this, to spot and isolate the phenomena brought into being by this kind of rotation, and possibly to find ways and means of countering this, perhaps by drugs.

In addition to the rotating room, which is a rather unique and yet very simple new tool to do these things, we have a human disorientation device down there, which is, I would say, about the size of a large cement mixer, and looks something like that, a drum that can be closed up with a human occupant, and spun around either its vertical axis or horizontal axis or both, and this can be very precisely controlled. We can pattern any forms or combinations of rotations in this that we desire, with the rates of rotation running from a tenth of degree of arc per second up to 300° of arc per second.

This is a precise tool with the instrumentation to exploit the phenomena we isolate on the rotating room. I believe I can say with no challenge that there are no facilities that have these capabilities in existence any other place we know.

The CHAIRMAN. Tell me, is your discomfort when you are in that 13-foot room, is it due to seasickness?

Captain PHOEBUS. It is very closely parallel to that. We have found, in keeping people in there, for example, that some people after a period of time can fairly well adapt.

The CHAIRMAN. Did you get over your seasickness there?

Captain PHOEBUS. I was only in the rotating room about 10 minutes, sir, and when I came out of it I didn't fully recover my normal sense of well-being for about 3 hours afterward. We have found in some cases that those who are most susceptible do not recover for a matter of days afterward.

On the other hand, some of our people who stayed in there as long as 48 hours and adapted to it, found the rather interesting phenomenon that upon cessation of the rotation they went back through this discomfort cycle again, before they came back to normal.

The CHAIRMAN. In other words, they have to orient themselves again.

Captain PHOEBUS. That is correct.

I might add, with us today are at least two people who have ridden on the device. General Flickinger rode on it, and surprised me by being probably one of the least susceptible people we have had on it.

General FLICKINGER. That is correlated with a lack of intelligence.

The CHAIRMAN. Less susceptible to what, now?

Captain PHOEBUS. He is a little resistant to motion sickness. Dr. Randt has ridden on it; I think he had about the same experiences I did.

Dr. RANDT. Worse.

The CHAIRMAN. I understand from our technical director the Navy has invited members of this committee to take a ride in this room.

Captain PHOEBUS. Yes, sir, and I would frankly recommend it to you as a unique experience. You can, I might add, stop any unpleasant

effects by merely holding your head completely still. Now, this is difficult to do. If one tries to get up and walk across this room the very slight head movements one has in walking are sufficient to bring on this phenomenon. But if you just sit there and use your eyes rather than moving your head you are comfortable.

The CHAIRMAN. Is it your view this is a problem that may be handled very similarly to what you do with seasickness?

Captain PHOEBUS. Well, we would hope that we will be able to develop drugs and evaluate drugs on this device much more accurately than we have ever been able to do in relationship to seasickness or any other kind of motion sickness. We have the capability of doing that and the program is underway now.

The CHAIRMAN. Yes, sir. Gentlemen?

Mr. Riehlman?

Mr. RIEHLMAN. Did I understand you to say programs are under way now in research for this type of medicine?

Captain PHOEBUS. Yes, sir.

The CHAIRMAN. That is one problem you have to overcome, if you are going to use space a great deal, isn't it?

Captain PHOEBUS. We feel this is one of the most important things to be investigated in space. For example, suppose through this disorientation situation alone, not to mention the other stresses to which a man is subjected, he becomes nauseated and vomits in a weightless condition. I can't think of anything that is much more likely to be a real emergency than a man vomiting in the weightless state, because he may not be able to get rid of the vomitus and smother. If we can find out enough about this phenomenon to either select people least susceptible, or to guard them with drugs against this sort of thing, we have at least answered one little problem among the many.

The CHAIRMAN. Is it a problem that you can put a definite time period in which it can be solved?

Captain PHOEBUS. I would hesitate to try to put a definite time period on this other than for a quick fix sort of thing. I would guess we will have some of the answers within the next year or so, adequate for our immediate purpose. But to work out the entire story involved here might take a considerable period of time.

The CHAIRMAN. One more question: Did these monkeys, primates, you call them, did they have that problem when they were in the missile?

Captain PHOEBUS. We don't know. We had no devices to measure this. And their flight was rather short.

The CHAIRMAN. They gave no evidence of having been through that when you removed them?

Captain PHOEBUS. No, sir.

Mr. RIEHLMAN. Mr. Chairman, may I ask whether the Captain has knowledge whether any of the other services in their research programs are following up this type of activity with respect to medicine to cure this sickness?

Captain PHOEBUS. There has been a coordinated type effort in the search for sea sickness remedies going on among all three services, wherein we have utilized the Military Sea Transportation System with troops moving back and forth across seas in rough Atlantic crossings, and with staff members on those ships administering various

drugs to them to evaluate the effectiveness of these drugs. This was an effort initiated by personnel in our Office of Naval Research, but participated in by Army, Air Force, and Navy scientists.

Mr. RIEHLMAN. What they have discovered up to this point, wouldn't it be helpful in your research program?

Captain PHOEBUS. Of course, We are just going to find out whether the same drugs or newer drugs coming up can do the job for us.

Mr. RIEHLMAN. This is going to be of tremendous interest to NASA in its field of activity, and you would expect proper coordination between your activities and NASA in their research?

Captain PHOEBUS. This is exactly what we intend. We have had conversations with Dr. Randt and others of NASA. We have already submitted a proposal for support of this research from NASA, which will serve to accelerate it. I, of course, cannot speak for their decision in this matter. But I have been led to believe they are interested.

The CHAIRMAN. Mr. Daddario?

Mr. DADDARIO. Captain, you are satisfied that there is proper coordination between Navy and the other services, and also between the Department of Defense and NASA?

Captain PHOEBUS. Yes, sir.

Mr. DADDARIO. And you feel the coordinating activity arranagement within the DOD is going to work out insofar as keeping in coordination at a proper level in the future?

Captain PHOEBUS. I think the way in which it is shaping up now—I don't know what I will tell you 6 months from now—but at the present time it looks as though it would be eminently satisfactory.

Mr. DADDARIO. You also believe all these facilities the Navy has can perform a function for the country and also can cooperate with NASA in order to perform some of NASA's requirements in the future?

Captain PHOEBUS. Exactly.

Mr. DADDARIO. Now, my question goes, then, from that point to what can NASA do to help out—well, to perform its responsibilities in this space field, in addition to the facilities and the personnel which the Navy now has, what can it accomplish beyond that by building up facilities of its own to the extent of a 60-man force such as Dr. Randt described yesterday?

Captain PHOEBUS. I am speaking for myself here. My opinion is this: In the field of space sciences relevant to putting man into space, the Armed Forces, of course, have a big lead on anyone else because we have been working toward this for a long time.

On the other hand, as I understand it, part of NASA's responsibility is to use the space medium to exploit or develop biological sciences per se which are in some instances not relevant to putting a man in a space craft.

It is my understanding that the major purposes of their inhouse research facilities is in this second field. I, therefore, see no conflict between their inhouse effort and ours. These are in two different areas, primarily. There is overlap, of course. The fundamental work in biosciences will inevitably feed into the space medical problem of putting men into space. But I personally see no unnecessary duplication or overlapping in NASA's establishment of this facility. I have talked with them, I have a fair understanding, I think, of what they intend to do with this, and it doesn't worry me in the slightest; and I don't think we are treading on each other's toes.

Mr. DADDARIO. Can this requirement be developed on top of our present facilities? If NASA did not decide to build up its facilities could the Department of Defense take care of their requirements in this field which you—in which you say there would necessarily be some overlapping?

Captain PHOEBUS. Of course, we can take on this assignment if it is given to us. It has not been given to us in a major sense. The Navy has done a little work in this field, I believe the Air Force has done considerably more. You can ask General Flickinger about that.

We in the Navy at least have little motivation for moving into this area which is not particularly relevant to our military requirements. It is different when we are talking about exploiting the science of biology in the space medium, from our view of space as an operating medium to carry out the mission of the Navy.

Mr. MOELLER. Would you yield?

Mr. DADDARIO. Yes.

Mr. MOELLER. Captain, if this were to be carried on by the Navy and the other forces, would you then need to acquire the services of more people, more capable scientists, and so forth?

Captain PHOEBUS. Yes, sir.

Mr. MOELLER. Would you have to have more money to carry on the program?

Captain PHOEBUS. Of course.

Mr. MOELLER. Suppose NASA takes over and really explores this thing in the way you say you don't have the motivation for, would there be a reduction in your staff as of the present time and a reduction of funding?

Captain PHOEBUS. No, sir; because we will be working on different pieces of the problem. We are going to be continuing our efforts to get all the work done possible to enable the Navy if, as, and when it has a requirement for putting men into space, to put them up there and have them operate effectively as men and pursue the Navy's mission. The military aspect of this is quite different from utilizing space as a place where one expands fundamental knowledge of science.

Not that we are not interested in the fundamental aspects of it, because it will pay into our applied interests. But at the same time, if we were to embark upon any program to exploit bioscience in space, we would have to get some specialized people whom we don't have now. I think we could lay our hand on them easily, we know who they are. We would have to have certain expanded lab facilities. But I don't think we would, at least joyfully, take on such an assignment if it jeopardized our primary interest, which is the man in space type of thing.

Mr. RIEHLMAN. Would the gentleman yield for one question?

Mr. MOELLER. Yes, sir.

Mr. RIEHLMAN. I think in your statement you said your laboratories are not operating at the optimum rate at the present time.

Captain PHOEBUS. That is correct.

Mr. RIEHLMAN. If they are not, wouldn't you have in the present laboratory facilities space, and possibly not the personnel, but space to carry on additional projects?

Captain PHOEBUS. I would like to explain, sir, our people in our laboratories are as busy as little bees and can't find the time to do all they would like to do.

I would like to point out that they have a potential for expansion by adding additional people and very little in the way of additional facilities, to contribute much more than they are contributing. We are limited for budgetary reasons in the number of people whom we can employ in our laboratories at the present time. This is why we looked forward to this relationship with NASA with quite some anticipation, because if they can provide us with additional funds we can increase our efforts, which we want to do anyhow but haven't been able to.

Mr. RIEHLMAN. You wouldn't need additional facilities and space?

Captain PHOEBUS. Primarily not. In some instances, in order to get on with job faster we are going to need more space to house more people and perhaps a few instruments to work with.

Mr. RIEHLMAN. What you actually need are money and personnel?

Captain PHOEBUS. Money and personnel will solve all problems.

The CHAIRMAN. You would need more space at Point Mugu?

Captain PHOEBUS. Yes, sir. Here we have not yet built physical facilities to hold our Life Sciences Department. They are just in offices now and are actually doing their work on devices that have been already installed out there for engineering purposes: chambers, centrifuges, climatic rooms, shake tables, this sort of thing. This gives us a chance to ride piggy-back on something put in for another purpose, instead of putting it in for our own purposes. As we move further into the area of specific life sciences research out there we are to a degree going to need special facilities of our own that the engineers wouldn't otherwise think of having because they don't need them.

Mr. DADDARIO. What is the Navy's mission in space right now?

Captain PHOEBUS. I wish I could answer that specifically.

Mr. DADDARIO. The reason I ask that is that in view of some of the testimony you have just given about NASA having these requirements; you have actually projected yourself beyond the present requirements of the Navy because of some imaginary concept you have as to future needs and you have developed these talents, skills and abilities to take care of various eventualities for the future, even though these are eventualities you are not sure about at the present time.

Captain PHOEBUS. May I put it in a slightly different manner, sir? There is nothing we have yet done that is not an extension of our already existing requirements for knowledge in aviation medicine or to meet other Navy requirements. I am pointing out to you the way in which these things, which we have to a large degree embarked upon over a period of years in pursuit of our aviation medical requirements, are adaptable to space; and some of our ideas as to how we might proceed in the future to stay a jump ahead of the Navy's specific requirements for putting men into space.

Mr. DADDARIO. There is no argument at all with that. I think it is a fine thing. I think this is part of the problem here insofar as development of facilities for NASA are concerned. You as a normal requirement on top of your present experiences build up capacity for the future. You are, as you have said, a jump ahead. And I cannot see how it holds up, then, that you will not reach the point where the bioscience requirements of man in space will not normally develop

through the present facility elongations, and I am just concerned about how this orderly process may be affected by starting from scratch somewhere also rather than have a new agency such as NASA take its requirements and put them on the shoulders of the Department of Defense, on top of present facilities, so it can properly and logically work out its way in the manner through which experiments have worked out in the past.

Captain PHOEBUS. Mr. Daddario, I think it can work out either way, for NASA to carry out the biosciences sort of thing, or to give the assignment to the Department of Defense.

I would be happy personally no matter which way it comes out, and I think the rest of us would be. I don't think it is within my province to decide whether NASA will have inhouse facilities. Personally, I am in sympathy with their efforts along these lines. I don't, for example, foresee any particular reason why the Navy would be interested in extraterrestrial life other than the fact that perhaps some fundamental developments in biology may come out of these studies which will ultimately apply to something in which we are interested.

But I can't quite at the moment see—I don't have a crystal ball—how these more abstract scientific interests at the present time could have any direct relevance to our own military requirements.

Mr. DADDARIO. This committee is interested in whether or not another agency sets up a facility, for the reasons of dollars being spent, and spurting up of agencies all over the place.

Captain PHOEBUS. Surely.

Mr. DADDARIO. How many people do you have involved in this space medicine field?

Captain PHOEBUS. I would say in top-notch scientists scattered around these 6 laboratories there may be something in the ballpark of 75, in this vicinity. There are supporting technical and administrative personnel.

Mr. DADDARIO. Could you estimate the numbers of the people in support?

Captain PHOEBUS. Perhaps another 100 to 150, something of this sort.

I would like to point out, however, that these people are pursuing research established for things other than a space medicine requirement. They are becoming interested in this and perhaps orienting their work a little more toward the idea of it ultimately being applied to space. But to try to separate out these things and say this man is doing his work primarily or exclusively for our space medicine program of the future would be very difficult.

At New London, for example, I don't think that we are interfering in our space medicine interests in the slightest with their primary mission of supporting the submarine requirements. But some of the things they are doing for that requirement fit into this picture.

At Naval Medical Research Institute the work we are doing in vibration has applications in many other fields than space.

Similarly, our human calorimeter work and our telemetry are applicable. Our work in disorientation at Pensacola—we started to build that device 10 years ago—it took us almost that long to get it. But it wasn't with any thought of getting men into space that we started

designing it and doing preliminary work. It was to solve pressing aviation medicine problems, where our pilots were having difficulties with orientation.

How does one separate these things and say there are X people working on space? They are not working exclusively in this area, but only contributing to it through their efforts.

Mr. DADDARIO. This is one of the reasons, Captain, why I believe future requirements of space ought to be built up on top of present facilities because I don't think you can separate the experiences in the past from those you run into in the future.

Captain PHOEBUS. I am thoroughly in accord with that view.

Mr. DADDARIO. Can NASA set up a facility—if they set up a facility of 60 people, taking the figures you have given, I imagine 20 or 30 would be scientists, the rest would be in support. These people would certainly need to use the knowledge that has been developed from the Department of Defense?

Captain PHOEBUS. Yes, and they would, I am sure.

Mr. DADDARIO. Wouldn't there be loss of efficiency in the coordinating processes, loss of time in carrying over the results of the experiments from one place to another, the necessity of additional reports, the necessity of additional time spent in liaison, all that type of thing? Isn't this the kind of operation that tends not only to be overlapping, but to bring inefficiency, inefficient use of facilities, inefficient use of personnel and in the final analysis experiments that take longer to develop in this fast-moving age in which we are living?

Captain PHOEBUS. In my view, sir, the type of work they would initiate in the NASA inservice laboratory, this is my understanding of it, would not be duplicating or overlapping what we are doing, within the Navy at least. It would be in a different field.

I don't think in their inhouse facility NASA contemplates putting in a human centrifuge or disorientation device or human calorimeter. I think they are more interested in the biological type of experiment.

NASA will have to speak on this, but this is my understanding of it.

Mr. DADDARIO. That is all, Mr. Chairman.

The CHAIRMAN. Captain, you have made a most interesting and enlightening witness, and we appreciate it very much.

I think now we have the Air Force to hear this morning. To divide the time pretty equally, we would have to give over to the Air Force now. We have the general here.

Before you leave, however, I want to tell this subcommittee this: We have for the last year had on this committee staff Lt. Col. Francis J. Dillon, Jr., U.S. Air Force, who has done a very creditable job. He is from the Air Force and we are very proud of the fact he will have been here a year next July 15. The committee initially adopted a policy which I think is excellent, of rotating. After Colonel Dillon has finished his tour of duty, if you want to call it that, with the committee, he will go back to the Air Force and we want to give him really a lot of thanks for the fine job he has done.

So it becomes normal to rotate, and we have asked the Secretary of the Navy to send a commander over here and the Secretary of the Navy is selecting the commander, Comdr. Howard J. Silber-

stein, USN, has been selected by the Navy and he will report to duty here on the first of the month.

Since the captain is here and represents the Navy, I want to tell the captain, so he can take back to the Department of the Navy, the fact that we appreciate the fine cooperation the Navy gives this committee.

I know that Commander Silberstein will do an excellent job over here working with this committee on a loan basis for the period of a year. We appreciate that and I hope you will tell the Secretary of our appreciation.

Captain PHOEBUS. I certainly will. Thank you very much, sir.

The CHAIRMAN. He will report here about the first of the month. Thank you very much, Captain.

Next we have Brig. Gen. Don Flickinger, Assistant for Bioastronautics, Headquarters, Air Research and Development Command, the Air Force.

General, do you have someone you wish to have sit with you?

General FLICKINGER. Yes, sir; I would like to bring up Col. Karl H. Houghton, representing the Air Force Surgeon General, and Col. John R. V. Dickson, representing the Deputy Chief of Air Staff for Development.

The CHAIRMAN. Thank you. If they will have a seat with you—we are a little crowded in this small room here, but we will have better quarters next year in the new building.

Mr. RIEHLMAN. You are an optimist.

General FLICKINGER. Mr. Chairman and members of the committee——

The CHAIRMAN. Can the members of the committee see the chart, Mr. King?

Mr. KING. Very well, Mr. Chairman.

The CHAIRMAN. Now, General, we have a prepared statement from you?

General FLICKINGER. Yes, sir.

The CHAIRMAN. What I just told the captain applies also to the Air Force, that Col. Frank Dillon has done a magnificent job for the committee.

General FLICKINGER. We think so, too. We are very proud of him.

The CHAIRMAN. We are going to write the Secretary an official communication on his services, in the near future.

General FLICKINGER. We are most appreciative.

STATEMENT OF BRIG. GEN. DON FLICKINGER,[1] ASSISTANT FOR BIOASTRONAUTICS, HEADQUARTERS, AIR RESEARCH AND DEVELOPMENT COMMAND, U.S. AIR FORCE; ACCOMPANIED BY COL. KARL H. HOUGHTON, CHIEF, AEROSPACE MEDICINE DIVISION, DIRECTORATE OF PROFESSIONAL SERVICES, OFFICE OF THE SURGEON GENERAL, HEADQUARTERS, U.S. AIR FORCE, AND COL. JOHN R. V. DICKSON, DIRECTOR OF DEVELOPMENT PROGRAMING, OFFICE OF DEPUTY CHIEF OF STAFF, DEVELOPMENT, HEADQUARTERS, U.S. AIR FORCE

Mr. Chairman and members of the committee, it is both a privilege and pleasure to appear before your committee and have the opportu-

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[1] Biography of Brig. Gen. Don D. Flickinger, U.S. Air Force, MC, 19078A (Feb. 12, 1960):

PART I. NARRATIVE

Don Davis Flickinger was born in Erie, Pa., on Nov. 26, 1907. He was graduated from Los Angeles High School in 1925; received his A.B. from Stanford University in 1929; and his M.D. from Stanford University School of Medicine in 1933. In 1934 he was licensed by the State of Tennessee to practice medicine and immediately thereafter was commissioned a first lieutenant in the Army Medical Corps.

Lieutenant Flickinger's first assignment was as chief of the medical service at the U.S. Army Station Hospital, Fort McClellan, Ala. He received his flight surgeon's wings in 1937. Today, he holds the aeronautical rating of chief flight surgeon.

Lieutenant Flickinger's next assignment was at Carlisle Barracks, Pa., where he was a student at the Medical Field Service School. In 1935, he became chief of the surgical service at the U.S. Army Station Hospital, Presidio of Monterey, Calif. From July to November 1937, he attended the flight surgeon's course at the School of Aviation Medicine, Randolph Field, Tex. In December of that same year, he became chief of the medical service at the station hospital, March Field, Calif.; he also held the additional duty of group surgeon during the period of his assignment there.

In 1940, Captain Flickinger was transferred to Hawaii and was appointed senior flight surgeon at Wheeler Field. From August until October 1941, he was flight surgeon for the 14th Provisional Squadron, Clark Field, Philippine Islands. His next assignment was with the 7th Fighter Command in Hawaii. On Dec. 7, 1941, when the Japanese attacked, he was the medical officer of the day at Pearl Harbor.

From October 1942 until May 1944, he held the grades of major, lieutenant colonel, and colonel, while serving in the China-Burma-India theater as wing surgeon. In June 1944, Colonel Flickinger was returned to the United States and was assigned as executive officer in the Surgeon's Office, Air Training Command, Washington, D.C. On Aug. 5, 1944, he reported to Orlando, Fla., where he headed the aeromedical department at the Air Force School of Applied Tactics.

From November 1945 until December 1946, he was professor of air science and tactics at Harvard Medical School, Boston, Mass., during which time he also completed a graduate course in cardiology. Upon completion of this tour, Colonel Flickinger reported to the School of Aviation Medicine, Randolph Field, where he served first as chief of the department of internal medicine; then as director of research, and finally as director of medical sciences. It was during this tour that the Air Force became an independent branch of the military service and Colonel Flickinger elected to continue his career with the new organization and was formally transferred from the Army. In June 1949, Colonel Flickinger was appointed air surgeon of the Strategic Air Command's 8th Air Force at Fort Worth, Tex.

From this assignment, he reported to Headquarters, Air Research and Development Command, Baltimore, Md., in November 1951, to head the newly formed Human Factors Directorate. In February 1953, he was appointed Director of Research and later Assistant Deputy Commander of Technical Operations at Headquarters, Air Research and Development Command. He received his promotion to brigadier general in October 1954.

When the Air Force Office of Scientific Research was activated in Baltimore, in August 1955, General Flickinger was chosen to become its first commander, a position he held until January 1956. At that time, General Flickinger left for an oversea assignment and assumed command of the European Office, Air Research and Development Command, in Brussels, Belgium.

General Flickinger returned to Headquarters, Air Research and Development Command, Baltimore, in July 1957, to become surgeon and Director of Human Factors (later known as life sciences). This was the first time for an officer to be assigned these dual responsibilities. In May 1958, General Flickinger was given the additional duty of special assistant for bioastronautics to the commander, Air Force Ballistic Missile Division, Inglewood, Calif.; although he physically remained at Headquarters, Air Research and Development Command, Andrews Air Force Base.

In November 1958, General Flickinger was relieved from this last assignment and as Director of Life Sciences to assume the positions of assistant to the commander, Air Research and Development Command, for bioastronautics and assistant deputy commander for research; still retaining his title of surgeon.

In January 1959, General Flickinger's assignment was again changed. At this time he dropped his title of assistant deputy commander for research but retained the duties of assistant to the commander, ARDC, for bioastronautics and surgeon.

nity to present our biomedical research and development activities in support of national and Air Force programs toward manned space flight. I should certainly mention that it has been a source of con-

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General Flickinger is the son of Bonnie Davis Flickinger and the late George C. Flickinger, of Altadena, Calif. He has been active in aeronautical sciences, aeromedicine, and bioastronautics for the past 25 years.

PART II. PERSONALIZED MATERIAL

A. Interests

General Flickinger's hobbies include painting in water colors; collecting works of unknown, that is, inexpensive artists; and the study of the history of art and music, particularly ballet. He enjoys boating, swimming, tennis, and squash. He is also regarded as a skilled amateur chef.

2. He states that he has no unusual talents or skills.

3. General Flickinger acts as a volunteer worker to groups providing home hospitality and guide service to visiting foreign students and graduates. He is a Presbyterian by affiliation but does not engage in extra activities of the church.

B. Opinions, tastes, and evaluations

1. Champions French cuisine, especially beef and seafood dishes. Dresses conservatively. Expresses a marked liking for ranch-style housing; early American or oriental furnishings.

2. The general's taste in reading runs to philosophy, history, and the history of art. His taste in music centers on the old masters of the classics and ballet. He likes some modern art, the French impressionists, and representatives of the Dutch school of art. As a military man and seasoned traveler, he expresses no particular preference or liking of climate; but does like both mountains and seashore.

3. General Flickinger's philosophy on life is encompassed pretty much in the Golden Rule.

4. He demands absolute honesty in relationships with others.

5. Keeping his own enthusiasm under control has long been a continuing problem with the general. Once he delves into a problem, his ability to foresee a solution fires his imagination which, in turn, engenders an enthusiasm which he must and only with great difficulty manages to control.

PART III. FACT SHEET

A. Personal data

1. Born Nov. 26, 1907, Erie, Pa.; father, George C. Flickinger (deceased); mother, Bonnie Davis Flickinger.

2. Hometown address: 2357 Highland Ave., Altadena, Calif.

B. Education

1. Graduate, Los Angeles High School, Los Angeles, Calif., 1925.
2. Graduate, Stanford University, Stanford, Calif., A.B. degree, 1929.
3. Graduate, Stanford University Medical School, Stanford, Calif., M.D. degree, 1933.
4. Vanderbilt University Medical School, Nashville, Tenn., 1934.
5. Medical Field Service School, Carlisle Barracks, Pa., 1935.
6. USAF School of Aviation Medicine, Randolph Field, Tex., 1937.
7. Harvard Medical School, Boston, Mass., 1946.

C. Service dates

1. June–December 1934, chief of medical service, U.S. Army Hospital, Fort McClellan, Ala.
2. January–June 1935, student, Medical Field Service School, Carlisle Barracks, Pa.
3. July 1935–June 1937, chief of surgical service, station hospital, Presidio of Monterey, Calif.
4. July–November 1937, student, USAF School of Aviation Medicine, Randolph Field, Tex.
5. December 1937–January 1940, chief of medical service, station hospital, March Field, Calif.
6. February 1940–August 1941, senior flight surgeon. Wheeler Field, Territory of Hawaii.
7. August–November 1941, flight surgeon, 14th Provisional Squadron, Clark Field, Philippine Islands.
8. November 1941–October 1942, command flight surgeon, 7th Fighter Interceptor Command, Territory of Hawaii.
9. October–December 1942, station surgeon, Mather Field, Calif.
10. February 1943–May 1944, wing surgeon, Headquarters, India-China Wing.
11. June–August 1944, executive officer, surgeon's office, Headquarters, Air Training Command, Washington, D.C.
12. August 1944–November 1945, aeromedical department, Air Force School of Applied Tactics, Orlando, Fla.
13. November 1945–November 1946, instructor, Peter Bent Brigham Hospital, Harvard Medical School, Boston, Mass.
14. December 1946, chief, department of internal medicine, School of Aviation Medicine, Randolph Field, Tex.
15. January 1947–January 1948, director of research, School of Aviation Medicine, Randolph Field, Tex.
16. January 1948–June 1949, director of medical sciences, School of Aviation Medicine, Randolph Field, Tex.
17. June 1949–November 1951, air surgeon, 8th Air Force, Fort Worth, Tex.
18. November 1951–February 1953, director of human factors, Air Research and Development Command, Baltimore, Md.

siderable comfort and satisfaction to the Air Force to note the early and continued interest of your committee in the human aspects of space exploration and exploitation.

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19. February 1953–August 1955, director of research, assistant deputy commander for technical operations, Headquarters, Air Research and Development Command, Baltimore, Md.
20. August 1955–January 1956, commander, Air Force Office of Scientific Research, ARDC, Baltimore, Md.
21. January 1956–July 1957, commander, European Office, Air Research and Development Command, Brussels, Belgium.
22. July 1957–November 1958, surgeon, director of life sciences, and special assistant for bioastronautics, Headquarters, Air Research and Development Command, Andrews Air Force Base, Md.
23. November 1958–January 1959, surgeon, assistant deputy commander for research, and assistant for bioastronautics, Headquarters, Air Research and Development Command, Andrews Air Force Base, Md.
24. January 1959 to present, assistant to commander, ARDC, for bioastronautics, and surgeon, Headquarters, Air Research and Development Command, Andrews Air Force Base, Md.

D. Decorations and medals

Distinguished Flying Cross, December 1941; Air Medal, December 1943; Legion of Merit, April 1943; First Oak Leaf Cluster (Legion of Merit), December 1955; Soldier's Medal, December 1943; Presidential Unit Citation, 1944; Bronze Star Medal; American Defense Service Medal with Clasp, 1953; European and Middle East Campaign Medal, 1953; American Campaign Medal, 1953; Asiatic Pacific Campaign Medal, 1953; Chinese Flight Surgeon's Wings, December 1947; World War II Victory Medal, 1953; National Defense Service Medal, 1953; Chief Flight Surgeon, 1956; Theodore C. Lyster Award for scientific contribution to aviation medicine presented by the Aero Medical Association in 1956; Airpower Award for distinguished service in the field of science, presented jointly with W. Randolph Lovelace II, M.D., by the Air Force Association in 1959; John Jeffries Award for outstanding contributions to the advancement of aeronautics through medical research presented by the Institute of Aeronautical Sciences in 1960 (for year 1959).

E. Promotions

Rank	Temporary	Permanent
1st lieutenant	29 May 1934	1 Dec 1934
Captain	24 Jun 1937	24 Jun 1937
Major	4 Jan 1942	24 Jan 1943
Lieutenant colonel	23 Nov 1942	1 Jul 1948
Colonel	7 Sep 1943	27 Jul 1950
Brigadier general	11 Oct 1954	

F. Unusual experiences

First flight surgeon and so far as is known was the first physician to parachute into the jungle to give medical treatment and aid to survivors of an airplane crash in the China-Burma-India theater during World War II and assist in the evacuation of casualties.

PART IV. PUBLICATIONS

1. "Hemodynamic Studies on Constrictive Heart Disease," with C. Sidney Burwell, 1934–35.
2. "Venous Pressure Studies in Pregnancy," with C. Sidney Burwell, 1935.
3. "The Use of the Polygraph in Pilot Selection," School of Aviation Medicine, 1937.
4. "A Simplified Maze Text for Pilot Selection," School of Aviation Medicine, 1937.
5. "A Radio-Equipped Ambulance for Crash Rescue Work," with Capt. Harvey Porter, March Air Force Base, 1938.
6. "The Dynamic Accident Potential," with Capt. Harvey Porter, March Air Force Base, 1939.
7. "Relation of Crew Responsibility to Urinary Excretion Rates," B–17 transpacific flight, September 1941.
8. "Report on Use of Atabrine in Malarial Suppressive Doses on Operational Aircrews" B–17 transpacific flight, September 1941.
9. "Psychological Defections From Combat Flying by Aircrews; Contributing and Supportive Factors," CBI theater, 1934–44.
10. "Report on Jungle Rescue by Air Drop," CBI theater, 1944.
11. "The Use of Anti-Malarials in Flying Personnel," with Dr. Herman Chinn, School of Aviation Medicine, 1947.
12. "The Role of Histamine in Hypoxic States," with Dr. William Burkhard, 1948.
13. "Flash-Blindness in Aircrews During Use of Atomic Weapons," with 8th Air Force Team under School of Aviation Medicine direction 1950.
14. "Human Factors in Design and Operation of the B–47 Bomber," with team, Baltimore, Md., 1953.
15. "Human Factors in Weapon System Design and Development," with Dr. A. W. Hetherington, 1954.
16. "Future Trends in Aircrew Protection," AGARD Aero Medical Congress, Brussels, Belgium, 1956.
17. "Air Force Human Factors Program for Developing Manned Space Operations," Air University Quarterly Review, vol. X, No. 2, summer 1958.

The Air Force must consider the medium of space as an extension upward of our national atmospheric boundary and plan progressively for maintaining its security. Because man has represented the most reliable and effective component in combat aircraft, our work in space biomedicine represents a logical and required extension of aviation medicine which has progressively developed as a new and valuable area of science and technology since World War I.

May I deviate here to the point of saying that our own responsibility has always been completely clearly defined in aviation medicine, and that is to maintain the highest level of combat fitness of our flying personnel and our ground personnel.

Through this progressive program in aviation medicine, aimed toward steady improvements in crew safety and effectiveness, we were able to take advantage of rapid developments in other fields which made possible great increases in aircraft performance. This is typified now by our current successful X–15 flight program and our oncoming Dyna-Soar program which bring our pilots to the actualities of space flight.

Because the Air Force requirements for crew performance and recovery are always more urgent and demanding than in the case of nonmilitary flying, it is of course obvious that major civilian benefits have accrued on a timely basis.

Throughout the history of aviation medicine Air Force officers have dominated the literature. Among accomplishments of note are the outstanding work of Col. John Paul Stapp on deceleration, studies of animals in space-equivalent environments, starting in 1945 with the pioneering work of Colonel Henry, and the high altitude manned balloon flights of Lt. Col. David Simon. These well-known accomplishments are among the many contributions of the Air Force research team to future manned space operations; they were possible only because of a sound background of preparation in our laboratories.

If I may interject here, also sir, I would like to emphasize the importance of the management structure and capability of the Air Force research and development team, a major factor frequently overlooked in planning and implementing major scientific and techonological objectives. This management capability provides for careful and detailed integration of all important aspects of a new weapons system; propulsion, airframe, crew component, and ground support, in such a manner as will insure its operational usefulness at the required time.

The present U.S. Air Force capability, in this area, is greater than at any time in the past. We have between 1,200 and 1,400 Air Force life scientists and technicians actively engaged in studying the prob-

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18. "Biomedical Aspects of Space Flight," Eighth General Assembly, AGARD, NATO, Copenhagen, Denmark, October 1958.
19. "Results of Animal Investigations in Space Vehicles to Date," 30th annual meeting of the Aero Medical Association, Los Angeles, Calif., April 1959.
20. "Experimental Crew Selection Techniques in the U.S. Air Force," AGARD, NATO, Athens, Greece, May 1959.
21. "Personnel Selection and Training for Space Flight," 10th Congress of the International Astronautical Federation, London, England, September 1959.

PART V. COMMITTEE MEMBERSHIP

1. Member of the National Aeronautics and Space Administration's Life Sciences Advisory Committee, 1958.
2. USAF delegate to the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization; member of AGARD Aeromedical Panel, 1958.
3. Member of the Executive Council of the Armed Forces-National Research Council Bioastronautics Committee, National Academy of Sciences, 1958.

lems of aerospace. Prior to the establishment of the NASA, the Air Force had proceeded with the development of a manned ballistic space capsule to the point of a completed mockup, a development directly attributable to the fundamental knowledge and skill of the Air Force scientific and engineering team.

It is interesting to note that at the end of World War II, our Nation was the acknowledged and unquestioned leader in aviation medicine. Our crew protective devices were copied by all other major military powers. To this day, the Air Force biomedical capability represents the largest single competency to support manned aerospace flight in the Western World.

During these past years, as my esteemed colleagues from the Army and Navy have pointed out, our program has been closely correlated with the programs of the U.S. Navy, U.S. Army, and other Government agencies, making full use of each other's service facilities or capabilities.

For example, the U.S. Navy centrifuge at Johnsville, Pa., which Captain Phoebus mentioned, has been employed on many occasions by Air Force investigators.

In a like manner, the Army Chemical Center's excellent staff has supplemented our limited capability in the chemical hazard area and Army Ordnance for years has developed ejection catapults for Air Force use.

As in the past with NACA (and now with NASA) in the X–15 program, the Air Force has contributed biomedical support to the X series of experimental aircraft. The first true full pressure space suit emanated from these efforts. At the present time our biomedical resources are being utilized by NASA in direct support of Project Mercury.

In addition, the Space Task Force is currently utilizing the full-time services of Air Force medical personnel plus an extensive team of medical specialists to be used for the medical monitoring and recovery aspects of the Mercury flights.

May I refer here, Mr. Chairman, to a chart showing a breakdown of the specific activities in support of NASA by calendar year.

Prior to October of 1957 we had done considerable amount of biomedical work studying the problems of manned space flight. Immediately after Sputnik we directed our efforts toward the development of a single manned ballistic capsule which shortly was expanded to comprise the Air Force man-in-space program. Under direction from the Advanced Research Projects Agency, this program was reduced in scope, shortened in time, and renamed Man in Space Soonest (MISS).

In 1958 when NASA was formed and Congress gave them the responsibility for man in space, we furnished them all of the engineering data and some of our project personnel to go with the Mercury project. These supporting services have continued, and we have full time key space biomedical people with NASA both at the task force level and at headquarters.

We have continued to provide consultations to Project Mercury and we set up quite early both a 3-year and a 5-year long-range plan for estimating the total bioastronautics R. & D. for the entire country pursuing an active program on a broad front toward manned space flight.

Also in 1958, as Captain Phoebus mentioned, we organized and participated in the Bioastronautics Committee under the aegis of the National Research Council.

Also, as you know, we were responsible for a portion of the astronaut selection program.

In 1959 the Aeromedical Field Laboratory, at Holloman Air Force Base, was chosen by NASA to begin the animal training for the chimpanzees who will later on ride the Mercury capsules in ballistic flights and orbital flights, prior to the astronauts. They were all volunteer champanzees.

The CHAIRMAN. The question has come up, General, one of our members wants to know how you get a chimpanzee to volunteer?

General FLICKINGER. We train him to sit quietly in a small seat, for several days, and then offer him a banana on the one hand, or an apple on the other, and if he takes the banana he is a volunteer, and they almost always do.

We also have participated in some of the Little Joe and Big Joe shots that have been supported through our School of Aviation Medicine, Aerospace Medical Center; and again, like the Navy, we are conducting special deceleration studies, and they, in contradistinction to what Captain Phoebus talked about, have been in the direction of studying impact loads and some of the more severe dynamic perturbances during the reentry pattern.

All in all, it has resulted in a very comprehensive combination of resources between the Navy and ourselves, directed toward this problem of protection against the vehicular dynamic forces during launch and reentry.

And then, as you know, we have done a tremendous amount of work on the subject of weightlessness, studying both the human reactions in short-term weightless flights, and also in some of our animal work going back as early as 1949. And it is, I think, also interesting—since the chairman and the committee were interested in the reaction of people on the rotating room, I can personally testify to the close cooperation maintained with the Navy in the use of this unique facility.

The CHAIRMAN. You were in the room yourself too?

General FLICKINGER. Yes, sir.

The CHAIRMAN. You have been in it?

General FLICKINGER. Yes, sir. I was a subject, and they want to get me back and spin the room faster to try to break me down. I am willing to do anything for research, but I just haven't been able to find the time to do this.

We were very much interested in studying the weightless effects during the short-term flights in the human, and after some 300 flights, found a certain percentage of people who would have nausea, vertigo, and sometimes vomiting, in the weightless state. This intrigued us and we got together with Capt. Ashton Graybiel who is responsible for the work at Pensacola, and worked out, in very short order, without a lot of corespondence, a plan by which we have taken the susceptible people among our subjects down to the rotating room to find out if this might be a simple test on the one hand to determine excessive susceptibility to nausea and vertigo in the weightless state and, on the other hand, the possibility of using this rotating room to train people to avoid certain configurations of activity so they wouldn't become nauseated.

The CHAIRMAN. You are an aviator, yourself, a flier?

General FLICKINGER. Yes, I had a pilot's license, sir, but when I joined the Air Force they let me fly a while and then thought I would be better off just being a doctor. But I have a lot of time; yes, sir.

The CHAIRMAN. And Captain Phoebus is also a flier?

General FLICKINGER. Yes, sir.

The CHAIRMAN. May I ask you then, whether these tests have any relation to tests for flying? Would there be any similarity at all?

General FLICKINGER. Yes, sir. One of our basic requirements for trainee pilots is that they be capable of maintaining a stable terrestrial orientation during all positions and phases of 3-dimensional atmospheric flight. If a conflict arises between his visual perception of position and what other sensory impulses tell him, then he must be capable of accepting the indications from his instruments without becoming dizzy or confused. The rotating room could certainly prove to be a useful additional test to be given applicants for flying training.

It is a very intriguing field.

In 1960 we began the KC–135 weightless flights to train the astronauts in the technics of eating, drinking, and performing purposeful acts in the zero gravity state. We finalized with NASA the medical support to the actual launch operations at Canaveral and joined with the Army and Navy to provide these specialized medical personnel to the recovery and impact areas where the first astronaut will come down. We have a USAF medical officer assigned at DOD level for the responsibility of working with NASA on this range-monitoring problem and we have subsequently established a training course for these medical monitors at Cape Canaveral.

After Dr. Randt was appointed Director of Life Sciences for NASA, he called a meeting of the DOD–NASA liaison committee on bioastronautics during which he outlined both his organization and research objectives. He further stated that he expected the services to provide continued support to future man in space programs and at the next meeting would welcome proposals from us in the field of aerospace medicine. The handout which you have, Mr. Chairman, consists of a letter directive which we sent all of our laboratories, immediately after this first DOD–NASA Life Sciences Committee meeting. I believe the concise statement contained in the letter gives full evidence of our determination to provide NASA with all of our knowledge and capabilities in the field of space biomedicine. The completed document, which will be ready for distribution tomorrow, represents, in our opinion, a complete program for research, development, and test in support of manned space flight whether it be for military or peaceful scientific purposes. At the present time, insofar as the human component is concerned, there are no real differences between these two objectives.

The CHAIRMAN. Fine. Fine.

General FLICKINGER. This completed document, then, represents our biomedical program in support of the Air Force Dyna-Soar program, and we believe that it covers all requirements which NASA would have in putting a peaceful scientific observer into space. It does not include any specific proposals of work to be supported only by NASA since we feel that our total program is pertinent and vital to their interests as well as our own. We would expect and hope that certain specific

areas of this program would be of sufficient interest to them to merit further discussions toward more rapid and timely consummation of results through their provision of additional resources, funds, and personnel, to our laboratories. We consider this program of bioastronautics to be of vital importance to the total national space interests and objectives, both presently and in the future.

At this point in time no one can foresee the full impact of the space age on the future scientific stature, economy or security of our Nation. The challenges facing the total community of life scientists are far greater and more encompassing than ever existed in the past. Only by continued growth and expansion of both military and civilian biomedical resources and competence can we hope to maintain our future national leadership.

Thank you very much.

The CHAIRMAN. Thank you very much for a fine statement, General.

You read into the record the major areas of bioastronautics as shown by the chart?

General FLICKINGER. Yes, sir, it is contained on the first page of this particular document, which we will follow up through your permanent staff in probably the next 24 hours with a complete rundown in all areas of everything we are doing, and where.

The CHAIRMAN. That will be a part of the record.

(The letter referred to above is given without its attachments. The report resulting from the letter is in the hands of the committee but is not reproduced because it has been stamped "For Official Use Only," and is a closely written book of 198 pages.)

HEADQUARTERS, AIR RESEARCH AND DEVELOPMENT COMMAND,
U.S. AIR FORCE,
ANDREWS AIR FORCE BASE,
Washington, D.C., May 6, 1960.

Reply to attention of: RDGBL-1.
Subject: Biotechnological research and development capability for manned space flight.

1. The complexity and cost of research and development leading to a manned space capability are so great as to require a coordinated national effort. The largest capability in this respect is that in the Air Force. NASA has recently established a life sciences division and has indicated an intention of building a life sciences facility. They do, however, intend to continue utilizing Air Force research and development capabilities. In general, work requested by NASA will be supported by NASA funds.

2. For purposes of better coordination and to assist NASA to achieve their goals in the man in space effort, it is essential that this headquarters have descriptive material describing the complete spectrum of space oriented life sciences research and development being conducted within the Air Force.

3. It is requested that commanders of all ARDC life sciences facilities cooperate with persons instrumental in preparing the report described below.

4. For the purposes of this report, the life sciences effort is divided into the following listed major areas. The chairman for each area is shown.

I. Radiation: Lieutenant Colonel Lifton.
II. Stress tolerances: Lt. Col. William R. Turner.
III. Capsule habitability: Mr. Robert Roundy.
IV. Human engineering: Dr. Julien Christensen.
V. Crew performance: Col. J. P. Stapp.
VI. Bioelectronics: Dr. Henning E. Von Gierke.
VII. Animal performance in space environments: Lieutenant Colonel Hessberg.
VIII. Field operational testing: Lt. Col. William Harris.

It is necessary that this report be as complete and as accurate as possible. Chairmen should assign only the best qualified individuals to accomplish it. Com-

manders who have not been assigned as chairmen should extend full cooperation in the completion of this effort.

6. Chairmen are advised that this report is to cover the entire Air Force effort and that in several of the areas work is being done at more than one facility. This will require contacting other facilities in order to properly complete the report. It is the responsibility of the chairman assigned to each area to assure that all research and development is included. Where a piece of work would appear to fall into more than one major area, chairman will contact the chairman of the other area so that duplication will be avoided.

7. Since this report will only be reproduced and assembled within Headquarters ARDC the finished report will be submitted on unused duplimat masters no later than June 1, 1960.

8. Attached hereto are a format, instructions, and an example; all to assist you in preparing identically designed reports. The combined report will contain a complete and up to date listing of the USAF bioastronautics research and development program.

For the Commander:

DON FLICKINGER,
Brigadier General, USAF, MC,
Assistant for Bioastronautics.

3 Atchs:
1. Format, 3 cys.
2. Instructions, 3 cys.
3. Example, 3 cys.

The CHAIRMAN. General, may I ask you this question——

General FLICKINGER. Anything, sir.

The CHAIRMAN. NASA now has certain fundamental responsibilities. Is the Air Force in such an attitude NASA could say to the Air Force, "Will you do a certain job for us on stress tolerances," we will say?

General FLICKINGER. Yes, sir.

The CHAIRMAN. Or on radiation or human engineering? And could you take that as a project and work it out for NASA, for instance?

General FLICKINGER. Yes, sir.

The CHAIRMAN. The other services are in a similar position, the Army and the Navy, aren't they?

General FLICKINGER. Yes, sir.

Mr. Chairman, I think, as someone yesterday mentioned, there must be something peculiar about medical people, and life sciences, because we find it extremely easy to coordinate our efforts and perhaps it is because we are raised in an atmosphere of what is the best for the health and well-being of mankind, so we not in competition for either fame or glory; instead it is simply a question of what is best for the country.

So when an idea or problem arises that NASA needs help on, I go to Capt. Cliff Phoebus or General McNinch or Colonel Taylor, in the Army, perhaps by phone, and with Clark Randt at NASA, and we will figure out how we can use our total resources to get the answer we need, in the most economical and expeditious fashion, and this really works that way.

The CHAIRMAN. Well, now, that is a very fine statement.

General FLICKINGER. This is a true one, sir.

The CHAIRMAN. I have to admit doctors know how to cooperate.

But I am also glad you can't regiment them.

So there are independent individuals working independently, there.

General FLICKINGER. In the services, sir?

The CHAIRMAN. Yes, in and out of the services.

General FLICKINGER. Oh, yes, sir.

The CHAIRMAN. I want to ask you this question:

What problems have developed for the Air Force thus far in the handling of the X–15 that you were not acquainted with beforehand?

General FLICKINGER. Well, in the first place, Mr. Chairman, starting at the beginning, we realized that the X–15 was going to fly a flight profile which, or course, was higher and faster than any before; it was a big jump. We also realized that there would be a transition from aerodynamics to ballistic controls; and during the reentry phase, when you begin to trade off your velocity for heat and g forces, that we would encounter a complex of heat loads and deceleration loads different and greater than we had ever exposed a pilot to before.

So our problems started right with the question of who is ideally suited to take on this job, based upon his professional skills, background, how much rocket engine time he had, his capability to learn new techniques such as the transfer from aerodynamic to ballistic controls, and, finally, his ability to withstand this new spectrum of physiological stresses and have enough durability of purpose and skill as would enable him to do the right thing if an unexpected event happened, and certainly this has been borne out by Scotty Crossfield of North American Aviation, the NASA pilot, and our own Air Force pilots, too.

We came very quickly to this problem of, you might say, the first life-support capsule in a space-equivalent environment where we had to design a completely effective pressurization and oxygen and pressure suit unit, all interrelated, and that was our X-15 suit, full pressure, which I would say again was the first full true space suit developed. This gave us quite a jump on future manned space flight.

Lastly, as I mentioned, the question of being able to counteract the imposed physiologic stresses of heat and the reentry g's by the individual and still enable him to carry out the very strict requirements for bringing the aircraft back and landing.

The CHAIRMAN. Your problems, then, were not unexpected, were they?

General FLICKINGER. No, sir.

The CHAIRMAN. Did you have any medical problem developing recently when the Air Force sent up planes to try to bring down that balloon which was—what, 80,000 or 100,000 feet up?

General FLICKINGER. The Navy balloon that has the cosmic ray package?

The CHAIRMAN. Yes.

And you didn't bring it down?

General FLICKINGER. No, they shot it with a considerable number of holes. But by that time it had apparently established a steady state buoyancy, with the density of the atmosphere, so it didn't make any difference really as long as it had even a few areas holding the internal helium together.

I don't think it is down yet, is it?

Captain PHOEBUS. I don't really know.

The CHAIRMAN. You put holes in it, and the helium didn't come out?

General FLICKINGER. That is right. At that altitude there wasn't enough diffusion back and forth to exchange gases at that height.

The CHAIRMAN. Did the pilots flying those planes, because they flew them out of their normal environment, did they encounter any particular problems of health?

General FLICKINGER. No. Our combat aircraft as well as the Navy's now, you might say, from the human protective standpoint, sir, could go on up beyond what our present powerplants can go. In other words, 100,000–120,000 feet. And the altitude record now that we hold again—we took back from the Russians—is what, 126,000?

The CHAIRMAN. And you would have no problems up that high?

General FLICKINGER. No, sir.

The CHAIRMAN. You mean medical problems?

General FLICKINGER. Correct.

The CHAIRMAN. Mr. Moeller, do you have a question?

Mr. MOELLER. Yes.

I will defer for a second, if you want to recognize Mr. Riehlman. I don't have any question right now.

The CHAIRMAN. Mr. Daddario.

Mr. DADDARIO. What is the Air Force's mission in space, General?

General FLICKINGER. That mission in space now is the X–15 program, which we are continuing, and the Dyna-Soar program.

Mr. DADDARIO. Taking all of what you have said into consideration you have built a capacity that involves utilization of some 1,200 scientists.

General FLICKINGER. Yes, sir.

Mr. DADDARIO. And through the course of the years you have built up the Air Force capacity by projecting your thoughts into the future and trying to figure out in every possible way what the national requirements might be, and you have built up your ability to take care of these requirements?

General FLICKINGER. That is exactly right.

Mr. DADDARIO. Over the course of time, could you give us an idea of about how far ahead of the present technological and mechanical situation you have been able to keep your capacities?

General FLICKINGER. Yes, sir. It varies for different components that go into a weapons system. In the biomedical area, we try to keep 4½ to 5 years ahead. We find this is about our safest margin, to insure being able, for instance, in a B–70, to have the total configuration for an effective air crew and their safe recovery in the event the aircraft is destroyed.

Mr. DADDARIO. You find that is a problem about comparable to what you would run into in a space satellite?

General FLICKINGER. Yes, except for my own self, I would rather have about 7 years in the space situation. Because when you put the extended time duration with these environmental hazards, it compounds the problem in the area of reliability for components; in other words, as against even, we will say, keeping a refueled B–52 up, say 48 hours, which we have done and for much longer than that, but that in itself is quite a technological triumph, to keep machine and man operating effectively. When you go to a significant space mission of, say, 2 or 3 weeks, your demand for reliability of components goes up very steeply.

Mr. DADDARIO. You are also keeping in mind these extra requirements, as you develop capacity?

General FLICKINGER. Yes, sir, we develop our program on the basis of our future weapon systems requirements which always come first. The biomedical support requirements to B–70, F–108, or Dyna-Soar, are of first priority. Having found satisfactory solutions for the crew problems contained in the weapon systems under current development, we plan our program of ongoing research and development to meet the requirements of future possible Air Force manned systems.

Mr. DADDARIO. It was partially because of this that you were able to provide NASA with the support they needed in the astronauts?

General FLICKINGER. Yes, sir; completely because of that.

Mr. DADDARIO. You agree, I presume, that the coordinating activities set up within the Department of Defense and NASA will take care of the coordinating requirements between NASA, as such, and the Department of Defense?

General FLICKINGER. Mr. Daddario, I want to give you the most honest answer. Because I think the motivation of this committee is so sincere in this direction, it is the least I can do.

Having grown up in a laboratory, I am always a little bit worried at how high a level you should have your workers coordinate.

Now, to put it another way, my own personal philosophy is one which we try to practice all of the time. If I have a problem, either for NASA or of my own, and I want the best and most expeditious coordination. I get my laboratory people to go to Johnsville or Fort Knox and sit down with their laboratory people.

Now, let me then say this, because I do want to answer you honestly.

Coordination at as high a level as the DOD, which, as you understand, is three or four steps above me, requires more effort and work to go above me from my laboratories than I ask from my laboratories now. This is because I try to keep them out of the business of paperwork; they are scientists and technicians, and I want the Government to get the most for its money. It can work, if the people who are doing it come with the best possible intentions and are capable of keeping the mass of paperwork away from the actual laboratory workers.

Mr. DADDARIO. Then, taking that into consideration, General, do you believe the Department of Defense has within itself presently the capacity to take care of our national needs so far as space is concerned, manned space flight?

General FLICKINGER. As far as manned space flight, unquestionably.

I think the Air Force can take on any aerospace mission that the people of America and Congress will support.

Mr. DADDARIO. What would it need to be able to build up the capacity to take care of our future requirements in space, to keep this 5- to 7-year jump you have referred to?

General FLICKINGER. We have taken an estimate of that, Mr. Daddario. Assuming that the requirement for a progress of manned military space vehicles would become apparent shortly after Mercury, and concomitant with Dyna-Soar, I would say, our own estimate is we would require not very much additional in facilities, but perhaps a third increase in personnel and about the same increase in funding, for the next 5 to 7 years. I am speaking now about the manned space flight area.

Mr. DADDARIO. Do you feel this would be a natural progress of your activity through the years ahead?

General FLICKINGER. Yes.

Mr. DADDARIO. Do you feel there may be a conflict that would prevent you from developing this potential if the facilities for man in space are built up within the National Aeronautics and Space Administration?

General FLICKINGER. I don't understand that their inhouse capability is going in any way to duplicate ours, Mr. Daddario.

Mr. DADDARIO. You don't understand that this will.

Looking at it from the standpoint of your own experience, take into consideration the fact of a man going to space, whether it be military or civilian, how can there be other than conflict in this area?

General FLICKINGER. Well, it is my understanding the armed services will get the bulk of the biomedical requirements for the man in space NASA efforts.

I am not talking about this other use of the space as a unique medium for the extension of biologic knowledge. But it is my understanding that we will be given the major part of the responsibility for the continued support of this man in space program.

Mr. DADDARIO. As you look at it, providing the development of this facility does not conflict with the normal growth of the Department of Defense activities insofar as man in space in the future is concerned, then you can see no conflict?

General FLICKINGER. I see no conflict on this, because I see this, as Captain Phoebus mentioned, also, as a completely different problem, or different area of biomedical interest from our own on the problem of a manned space system.

Mr. DADDARIO. What problems do we run into from the standpoint of justifying appropriations if people say to us you are spending X-millions of dollars in NASA to take care of man's requirements in space, and the Air Force is asking for X-millions of dollars to take care of man's requirements in space, and how do you justify the expenditures of both?

If the one prevails, let us say this is used as a means through which the money will be appropriated to these NASA facilities, and therefore taken away from you, how will it affect your future program and how will it affect the facilities you have built up in the past and the personnel you now have and whom you are directing into the future in the manner in which you have explained?

General FLICKINGER. Well, I think the most honest answer I can give to that, Mr. Daddario, is that I think it is a matter of educating the American public. We are only now in the very earliest period of space exploration, and the potential benefits to be derived from both exploration and exploitation are almost too much for any single mind to conceive.

It can have profound returns not only in terms of our own security of the military side, but also our own economy, and our own health problems, and everything else.

Now, as I understand it, if people, and I think they will have to eventually, realize first the challenge, the potential returns, and the costs of a broad national program of space exploration, I think when they realize that there is this other area that has been described by Dr. Randt, which has great potential returns, even in fields of agriculture

which could provide more and better sustenance for a much larger percentage of the world's population, and the direct contribution some of these biologic experiments in the space environment could very well have to disease processes I think once they have this better understanding, then there would be no problem for Congress to balance out the space resources in such a manner that would best suit the total interests of the Nation.

Mr. DADDARIO. The matter of education is certainly important, and you, Captain Phoebus, and Dr. Randt have certainly helped in explaining to the public generally just what we are doing, and I am sure anyone would be as impressed as I am with the capacity of the people who are doing this job for us.

But in this question of talking about funds again, don't you on occasion have difficulty in selling some of these programs that you develop, to your own people, in the Department of Defense? Aren't you in a constant fight to get moneys to do this job?

General FLICKINGER. Yes, sir. I suspect, though, that if you asked any energetic member of the Air Force R. & D. team, whether he be in propulsion, guidance and control, he would have to answer the same way: "We would always like to have a little more money than we have." But we have to have a balanced program in the Air Force; I fit into my little niche, and scramble to do the best I can with it.

Certainly, the Air Force, as a whole, I suppose, would like to have more.

Mr. DADDARIO. I understand.

But we might add to your problem—I hope we won't—by being faced with the proposition of having a duplicating or overlapping facility or the threat of it in another agency. And I hope before we are through with these hearings we can show that there is a difference and that they can exist together, and that they can exist without conflict.

One thing I am concerned with is that the experience that you have developed in the Department of Defense, I think we have shown in this instance that the Department of Defense and its various agencies can work together, coordinate. This is an outstanding example for the American public to see. I would hate to see anything done to take from this wonderful facility capacity for the future, and I am fearful of development of another agency somewhere else, the expenditure of millions of dollars there, that this will detract from the capacity of the Department of Defense and its agencies to build up this particular capacity. This is the fear I have. And I hope we can develop something to overcome this fear, as far as I am concerned personally.

The CHAIRMAN. Let me ask you, General, in handling the program you have listed there, would you get better results if that came through NASA as a request on a project for you to perform, or is it better initially to be a military project, an Air Force project, say? What would serve the purposes best?

General FLICKINGER. That question, I think, is very easy to answer, Mr. Chairman.

Everything that we are doing is in support of Air Force requirements, and as I tried to point out, when we look toward Dyna-Soar as a military space—man-in-space vehicle, we are actually looking at more difficult problems. Because we are asking that this particular

machine do more than, we will say, the Mercury capsule. What this amounts to is that if I am doing my job well and going along toward a manned military space capability, I am already covering every area of biomedical requirements NASA would have to support a scientific observer who is not required to be at a particular place at a particular time, not being required to exercise a system as we do militarily and to keep it operationally fit.

So, as I say, if I do my job well, then he would never have to initiate a project in any program. He would simply show his interest and we would get together, and then if he needed it expanded or wanted an answer sooner for his particular purposes, he would add money or people.

The CHAIRMAN. So that what you mean is if you do your job, you are going to help the Navy, the Army, NASA, and FAA?

General FLICKINGER. Surely.

The CHAIRMAN. Does FAA ever call on you to do any work? That is a new Federal agency.

General FLICKINGER. Yes, sir, I know it very well, and know some of the people they have now, because I used to work with them at the School of Aviation Medicine.

Do we, Karl, [Colonel Houghton] have requirements levied upon us from FAA?

Of course, prior to the setting up of their research laboratory at Oklahoma City, we did a lot of work for commercial aviation, and they used, for instance, our standards for pilot selection, pilot maintenance, and we have long cooperated on mutual problems and research activities. I know the Navy has, too. Such things as the testing out of many of their equipments, both for pressurization, oxygen equipment, and such new developments as blind landing aids. We have worked very closely with commercial and civilian aviation agencies.

The CHAIRMAN. They are doing it now rather than you?

General FLICKINGER. I don't believe they are actively in aviation medical research activities now.

The CHAIRMAN. Their purpose is to take over that. Then will you transfer your equipment to them?

General FLICKINGER. I don't think it is a question of equipment.

The CHAIRMAN. What about manpower?

General FLICKINGER. They have recruited some of our manpower.

The CHAIRMAN. They have taken some of yours?

General FLICKINGER. Yes, sir. Good people.

The CHAIRMAN. In that instance they will go ahead and perform some of the services you have been doing. Will you be able to contract your services and save money by doing that?

General FLICKINGER. I don't know, sir. I don't believe so.

The CHAIRMAN. You then think that is a duplication, don't you?

General FLICKINGER. Mr. Chairman, I should not and cannot respond on that point, because it wouldn't be fair to FAA. I really don't know enough about their charter that has been given them by Congress.

The CHAIRMAN. I am just curious to get the answers, to form a judgment.

General FLICKINGER. With what I know of their objectives—I suppose I can't speak as just a scientist, not in uniform, can I?

The CHAIRMAN. You can speak any way you want to here, General.

General FLICKINGER. I must confess, in all honesty, it does seem to me they are doing an awful lot of work that we have done in the past and will have to continue to do in the future.

The CHAIRMAN. I don't think we have scheduled any FAA witnesses. Perhaps we should have one from the FAA before we conclude our hearings.

I think you have been very fair. And I will say this: that I think you and the Navy this morning have given me a little bit better insight into how you work together. You have four or five agencies undertaking very similar type work, and I can see what is in the mind of my colleague, Mr. Daddario, and certainly I join with him in the goal that he is seeking, which is the utmost efficiency in the spending of the taxpayers' money.

I think, however, you have pretty well explained to us this morning how you try to cooperate and to prevent overlapping and duplications and waste of money.

I want to especially thank you for that.

General FLICKINGER. May I just make one final statement——

The CHAIRMAN. Yes.

General FLICKINGER (continuing). In support of Congressman Daddario's, I think, excellent motivation in this direction? Because it is a serious thing, this problem of training biologic and medical scientists in the future, and I think this is of great concern to most of us in the business, of how you develop a future pool of scientific resources for these new problems, whether they be manned space flight or the study of biologic phenomena in a unique environment.

Mr. CHAIRMAN. There are some areas, it seems to me, with which the Air Force is obviously not concerned. You mentioned one: If you do reach the Moon and want to colonize the Moon, at this point the Air Force is not interested in putting a colony on the Moon.

General FLICKINGER. No, sir.

The CHAIRMAN. And you wouldn't be interested in life under those artificial circumstances.

General FLICKINGER. No, sir. But I think, to my way of thinking, the key to national survival in the space age is one of, you might say, awareness and flexibility. In other words, we don't really know now what returns will come to the country pursuing one particular area of space exploration. I guess it would be fair to say that we don't know how secure we will have to make our space, because if you would have a lasting peace, then you could certainly go down the road of "Let's learn more about fundamental life processes so we can do away with degenerative heart disease and cancer," things like that, all of which might result from an emphasis in this direction of space biomedicine.

But here you have a future, and so many resources. How are you going to use them? If there is a military threat, it has to be put on this side, if there is a scientific prestige threat, it goes perhaps in a different direction.

The CHAIRMAN. It seems to me it boils down to this: It is all one big problem, and whether you put it in uniform or take it out of uniform, it has to be met.

General FLICKINGER. We all have to be good Americans.

Mr. MOELLER. Mr. Chairman.

The CHAIRMAN. Mr. Moeller.

Mr. MOELLER. You said in your prepared statement that at the end of World War II our Nation was acknowledged as the unquestioned leader in aviation medicine.

General FLICKINGER. Yes, sir.

Mr. MOELLER. Are you intimating now that possibly we have slipped? Do we know that another nation might be in a better position than we are at the present time? Why didn't you say 1959, for example?

General FLICKINGER. Well, yes; in aviation medicine we are still ahead of any other power in protective devices, anything else.

Mr. MOELLER. That is enough.

The CHAIRMA.N How about space? He said "aviation medicine."

Mr. MOELLER. Are we in any way in this field cooperating and seeking information from other nations of the free world, and is there any kind of cooperation going on here with the Soviets, for example? Are they willing to share any knowledge they have gathered in this area with us?

General FLICKINGER. Yes. We have very active coordinating groups through NATO, under Dr. von Karman. We have an Aeromedical Panel.

Mr. MOELLER. So we are sharing with them in this?

General FLICKINGER. Completely.

Mr. MOELLER. The Soviets haven't shared anything with us?

General FLICKINGER. No; they have taken things from us.

The CHAIRMAN. They have learned from us?

General FLICKINGER. Yes.

Mr. MOELLER. The statement is made in your biographical sketch that you were Medical Officer of the Day at Pearl Harbor at the time of the Japanese attack.

General FLICKINGER. Yes, sir.

Mr. MOELLER. Were there any situations that obtained on that particular day, where you found you were terribly wanting, a situation that might be repeated in 1960?

General FLICKINGER. Well, sir; of course, I think being one on the spot, I was struck by the fact that we in the fighting units had so little warning. It was a strange thing, we had gone on the alert 3 or 4 months before and had gone into revetments, and the alert order that was given to us 2 or 3 days before Pearl Harbor was to bring in all our aircraft, as an antisabotage measure, onto the parking apron. We had 94 P–36's and P–40's (all lined up wing tips together, and it was the perfect setup for an airborne attack). And that sort of shocked you: How do we get in a fix to set the things up for a surprise attack?

Mr. MOELLER. Were you prepared for that moment to handle the emergency? Are we all over the world, wherever we have our forces today, properly prepared to meet a situation like we met at Pearl Harbor? Yes, or no?

General FLICKINGER. You mean from the standpoint of military plan to take care of casualties?

Mr. MOELLER. That is right.

General FLICKINGER. Yes, I think so.

Mr. MOELLER. You feel we are prepared?

General FLICKINGER. I think our disaster plans, as far as care of casualties of our combat forces, is excellent.

Mr. MOELLER. As we heard yesterday, of course, preparations are being made to protect also civilian life. Do you feel we are moving in this direction as fast as we can go, not only for our uniformed people, but likewise for the civilians, also, in the event of a surprise attack?

General FLICKINGER. Congressman Moeller, I cannot respond on the civilian defense aspect, because I don't know enough about it.

Mr. MOELLER. My reason for asking these questions, I think we are sitting here letting a lot of time get away from us and perhaps we are not working as feverishly as we ought to, to prevent possibly some of the distasteful experiences you have been through at Pearl Harbor. I think this is something the American public ought to be alerted to and awakened to, and I think we have to look to you people——

General FLICKINGER. You almost have to live through one of these things, though, to really understand how hopeless and useless you feel.

Mr. MOELLER. But we had this one experience that should have taught us a lesson, that today we ought to be prepared; correct? To whom do we go, then, to get this thing implemented?

General FLICKINGER. Congress, I assume.

Mr. MOELLER. I know this is not really the general field of this inquiry.

The CHAIRMAN. Yes, it is really not within the province of this committee. We had an investigation on Pearl Harbor after the war, and were never completely satisfied.

Mr. MOELLER. I was thinking of that.

General FLICKINGER. I am sure Congressman Moeller realizes our position as military personnel that our complete responsibility is to safeguard our country. The people expect us to keep ahead in time of peace and in times of war to follow orders, because that is the only way a successful military action can take place.

I don't think the American public expects us in uniform to debate national policy, and I don't think we should try to either. In other words, if we feel opposed to national policy, even as regards our present situation, I believe we should get out of uniform. The American public, I don't believe want us to debate national issues, but instead want to feel that they have the best possible military machine that will respond quickly and effectively when needed. So I just say that, because I don't think that any of us can really discuss these issues above our responsibility as military people.

The CHAIRMAN. Our technical director has a question, General, to ask you before we break up.

General FLICKINGER. Yes, sir.

Dr. SHELDON. I have noticed in the Navy presentation this morning particular reference was made to the very fine Navy pressure suit which will be used for Project Mercury, and in your presentation reference was made to the very fine Air Force pressure suit which will be used for the X–15.

General FLICKINGER. It is being used.

Dr. SHELDON. I think this is fine, each service takes credit. But can we also assume all the technical information that has been developed by each of the two services independently has also been shared,

so each suit has the full benefit? I think the record leaves this point as rather a sign of competition.

General FLICKINGER. Oh, no, Dr. Sheldon. Far from it. Our entire pressure suit development, right from the start back when we made the first pressure suit, has been completely integrated between the Navy and ourselves, and this has been the best possible situation. There is an element of competition, and that is good, as in any other field of enterprise. It so turns out, though—and I don't think altogether fortuitously, that the Navy mark 4 and our own MC–2 or X–15 suit, both have advantages, and it gives us, you might say, a complete spectrum. Theirs has capabilities in the survival area, in terms of ground survival, water, cold water, things like that, whereas ours wasn't particularly developed in that direction.

Ours has perhaps a little better capability to give mobility under an equal amount of pressure. But my point is that these were each developed with complete integration of all the test data and everything else. And we need them both.

Dr. SHELDON. Thank you, sir.

The CHAIRMAN. If there are no further questions, General, we want to thank you very much, and we want to thank you, Captain Phoebus.

The committee will stand adjourned until further notice.

(Whereupon, at 12:10 p.m., the committee adjourned sine die.)

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